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Screening Level Ecological Risk Assessments of Some Military Munitions and Obscurant-related Compounds for Selected Threatened and Endangered Species

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Final Report

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ABSTRACT: Preparation for anticipated, unknown, and invariably adverse battlefield conditions requires military training activities involving military smokes and obscurants (S&Os) and related chemical compounds, and can result in the release of other chemical agents and military unique compounds (MUCs) associated with munitions. This study evaluates the potential long-term impacts on selected threatened and endangered species resulting from dispersion and deposition of vapors and particles found in the fog oils, hexachloroethane smoke, colored smokes, white phosphorus, and obscurants such as brass flakes and graphite flakes used during training. Residue from these constituents can deposit directly on plants and prey species favored by higher vertebrates and other species or can be taken up by plants and prey species from the soil. From the literature and installation use reports, the authors develop estimates of toxicity and exposure to calculate installation-specific screening-level risk for selected threatened and endangered species.

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Conversion Factors

Non-SI* units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
Acres	4,046.873	square meters
cubic inches	0.00001638706	cubic meters
degrees Fahrenheit	(5/9) x (°F – 32)	degrees Celsius
degrees Fahrenheit	(5/9) x (°F – 32) + 273.15.	kelvins
feet	0.3048	meters
gallons (U.S. liquid)	3.785	liters
inches	02.54	centimeters
miles (U.S. statute)	1.609347	kilometers
pounds (mass)	0.4535924	kilograms
square feet	0.09290304	square meters
square miles	2,589,998	square meters

*_Système International d'Unités_ ("International System of Measurement"), commonly known as the "metric system."

Preface

This report is a deliverable product under military direct-allotted Department of the Army project A896, “Base Facility Environmental Quality”; Work Unit number 3B6GFD, and is part of a Science and Technology Objective. The technical monitor at the start of the project was William Woodson; the current Technical Monitor is Scott Belfit, DAIM-ED-N.

This report was prepared by employees of Menzie-Cura & Associates, Inc. and by Thomas Smith of the Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL), Installations Division (CN), Land and Heritage Conservation Branch (CN-N) and Jeffrey Steevens of the ERDC Environmental Laboraory (EL). The CERL Principal Investigator was Thomas Smith.

This report was initiated under the general supervision of Steve Hodapp Chief, CEERD-CN-N; the current Chief of CN-N is Alan Anderson. Dr. John T. Bandy is Chief, CEERD-CN. The associated Technical Director is Dr. William D. Severinghaus, CEERD-CV-T. The Director of CERL is Dr. Ilker Adiguzel. Technical supervision was provided by Steve Hodapp, Threatened and Endangered Species Manager; the current TES Program Manager is Timothy J. Hayden.

COL Richard B. Jenkins was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

Background

Preparation for anticipated, unknown, and invariably adverse battlefield conditions requires military training activities involving military smokes and obscurants (S&Os) and related chemical compounds, and can result in the release of other chemical agents and military unique compounds (MUCs) associated with munitions.

There is little doubt that the S&Os typically used during training and maneuver exercises may cause short-term irritation and effects via inhalation to some receptors. A purpose of this analysis is to evaluate the potential long-term impacts resulting from dispersion and deposition of vapors and particles found in the fog oils, hexachloroethane smoke, colored smokes, white phosphorus, and obscurants such as brass flakes and graphite flakes. Residue from these constituents can deposit directly on plants and prey species favored by higher vertebrates and other species or can be taken up by plants and prey species from the soil.

Similarly, long-term use of munitions can lead to measurable concentrations of MUCs such as TNT, RDX, and related compounds in soil, which can be taken up by plants and other prey items through terrestrial food webs to which wildlife are exposed. Concentrations in the environment accumulate primarily through unexploded ordnance (UXO) or from low-fired ordnance resulting in an incomplete fire of a munition.

Many threatened and endangered species are associated with military training areas where S&Os and MUCs are released. Specific endangered species associated with Army installations have been identified. The installations reviewed in this report vary in location, geography, ecology, and mission.

The installations and their mission category are:

State	Installation	Category	State	Installation	Category
Alabama	Fort Rucker	TI	Missouri	Fort Leonard Wood	TI
Arizona	Yuma Proving Ground	PG	North Carolina	Fort Bragg	MI
California	Fort Irwin	TARC	Oklahoma	Fort Sill	TI
Georgia	Fort Benning	TI	South Carolina	Fort Jackson	TI
Georgia	Fort Gordon	TI	Kentucky	Fort Knox	TI

State	Installation	Category	State	Installation	Category
Georgia	Fort Stewart	MI	Texas	Camp Bullis	TARC
Kentucky	Fort Campbell	TI	Texas	Fort Hood	MI
Louisiana	Fort Polk	TARC	Texas	Fort Sam Houston	TI
Mississippi	Camp Shelby	TARC			

The mission categories are:

- MI — Maneuver Installations: Major Army power projection platforms that provide facilities and resources to house, sustain, maintain, train, and deploy major combat forces. These installations also provide the capability to conduct developmental and operational testing and experimentation to test concepts for future forces.
- TI — Training Installations: U.S. Army installations that house schools for each Army branch where doctrine is written. These installations provide entry, functional, and specialized training. They also provide the capability to conduct developmental and operational testing and experimentation to test concepts for future forces.
- TARC — Training Areas and Reserve Component training sites: These installations provide facilities to conduct large-scale unit training for active and Reserve components but vary in terms of characteristics, capabilities, and organization.
- PG — Proving Ground: These facilities support developmental tests to evaluate battlefield application of new technologies over a wide range of terrain and climactic conditions. Testing includes all types of equipment and munitions.

For this screening-level ecological risk assessment, S&Os are:

fog oil smoke	(o-Chlorbenzol)malonitrile (CS)
hexachloroethane (HC) smoke	Dibenz(b,f)-1, 4-oxazepine (CR)
white phosphorous (WP) smoke	titanium dioxide
colored smoke (red, green, yellow, purple)	polyethylene glycol (PEG)
brass flakes	graphite flakes
terephelatic acid	

For this screening level ecological risk assessment MUCs are:

1,3,5-Trinitrobenzene (1,3,5-TNB)	1,3-Dinitrobenzene (1,3-DNB)
2,4 – Dinitrophenol (2,4-DNP)	Dinitrotoluene isomers (e.g., 2,4 – Dinitrotoluene; 2,6 – Dinitrotoluene)
High Melting Point Explosive (HMX)	Nitrobenzene (NB)
Nitroglycerin (NG)	Nitrophenol isomers (e.g., 2 – Nitrophenol; 4 – Nitrophenol)
Pentaerythritol Tetranitrate (PETN)	Cyclotrimethylenetrinitramine (RDX)
Trinitrophenylmethylnitramine (Tetryl)	2,4,6-Trinitrotoluene (TNT)

In this document, S&Os and MUCs are also referred to as contaminants/chemicals of concern (COCs) or contaminants of potential concern (COPCs).

For purposes of this ecological risk assessment, threatened and endangered species (identified in accordance with the Endangered Species Act [ESA]) of particular Army interest and selected Army installations they are associated with are as follows:

Indiana Bat (*Myotis sodalis*)
- Fort Campbell, KY
- Fort Knox, KY
- Fort Leonard Wood, MO

Gray Bat (*Myotis grisescens*)
- Fort Campbell, KY
- Fort Knox, KY
- Fort Leonard Wood, MO

Gopher Tortoise (*Gopherus polyphemus*)
- Fort Stewart, GA
- Fort Rucker, AL
- Camp Shelby, MS
- Fort Benning, GA
- Fort Gordon, GA

Desert Tortoise (*Gopherus agassizii*)
- Fort Irwin, CA
- Yuma Proving Ground, AZ

Golden-cheeked Warbler (*Dendroica chrysoparia*)
- Fort Hood, TX
- Fort Sam Houston, TX
- Camp Bullis, TX

Black-capped Vireo (*Vireo atricapillus*)
- Fort Hood, TX
- Fort Sam Houston, TX
- Camp Bullis, TX
- Fort Sill, OK

Red-cockaded Woodpecker (*Picoides borealis*)
- Fort Polk, LA
- Fort Bragg, NC
- Fort Benning, GA
- Fort Gordon, GA
- Camp Shelby, MS
- Fort Jackson, SC
- Fort Stewart, GA

This report builds on two literature reviews of the physical, chemical, and toxicological properties of chemical constituents in S&Os and munitions (Von Stackelberg

et al. 2004, 2005). From the literature and installation use reports, the authors develop estimates of toxicity and exposure to calculate installation-specific screening-level risk for selected threatened and endangered species.

Objective

The objectives of this research are to:

- Provide a screening-level evaluation of the potential long-term effects of smokes and obscurants and selected military compounds on threatened and endangered species during typical training maneuvers using an ecological risk-based framework;
- Identify data gaps;
- Identify assumptions and uncertainties in the assessment; and,
- Provide recommendations for additional analyses that would further refine the estimates presented in this report.

Approach

To accomplish these objectives, the analysis was conducted by:

- Obtaining usage statistics for S&Os and MUCs for each installation for 2002;
- Developing exposure estimates in soil, plants, and prey items for the threatened and endangered species of concern for each installation;
- Developing toxicity reference values (TRVs) for the S&Os and MUCs; and,
- Combining the exposure and effects estimates to calculate toxicity quotients (TQ) for each species, chemical, and installation to determine the potential for ecological risk.

This report follows generally established ecological risk assessment procedures and practices (USEPA 1992, 1998) and previously developed ecological risk assessment approaches (Suter et al. 2001).

This report attempts to provide a uniform level of review and discussion of each installation, relevant species, and chemical/contaminant of concern and to provide equal treatment of each. However, due in part to the differing amounts and levels of installation-specific, biological, and S&Os and munitions use information available, this has not always been possible. Therefore, in some instances the level of treatment differs for those reasons and because of subjective judgments made by the authors. In all instances, the judgments made were intended to be conservative and follow established ecological risk assessment protocols (USEPA 1998, Suter et al. 2001). In all instances the researchers have attempted to address all relative information. In this review, relevant literature and reports are identified and summarized.

Mode of Technology Transfer

This information can be used in developing Biological Assessments under the Endangered Species Act, environmental assessments under the National Environmental Policy Act, and in other planning and management relative to threatened and endangered species and related wildlife resources.

This report will be made accessible through the World Wide Web (WWW) at URL:
http://www.cecer.army.mil

2 Description of Installations

U.S. Army installations with one or more priority threatened and/or endangered species were chosen for evaluation in this assessment. The following sections describe the site location and history, munition and smoke and obscurant use, and biological information available for each installation. Installations are organized alphabetically by state.

Fort Rucker, Alabama

Fort Rucker covers about 64,500 acres of southeast Alabama countryside in an area known as the Wiregrass, named for a wild grass indigenous to the region. Much of the main post is in Dale County, with the remaining government-owned and leased acreage in Coffee, Geneva, and Houston counties (http://www.rucker.army.mil/activities/ruckercommunity.html). Figure 1 [*]shows a map of the training areas, impact areas, and ranges at Fort Rucker.

All Army Aviation flight training is conducted at Fort Rucker. Table 1 summarizes the use of smokes and obscurants at this installation.[†] Table 2 summarizes the quantity of each type of ammunition used at Fort Rucker during 2002.

The gopher tortoise is found on Fort Rucker. Fort Rucker is located east of the Tombigby and Mobile Rivers, which is the eastern demarcation of western population of the gopher tortoise. The tortoises found on Fort Rucker are considered part of the eastern population of gopher tortoises, and while the western population is considered threatened, the eastern population is not. However, taking of tortoises on Fort Rucker is prohibited under state regulations. Detailed information about gopher habitat and forage areas for Fort Rucker is not available. However, as a screening evaluation, this report assumes that gopher tortoise is potentially exposed to military-related compounds used at Fort Rucker.

[*] Figures and Tables are grouped at the end of the chapter, beginning on page 22.

[†] Table 1 contains the summary of S&O use at all the installations discussed in this report.

Yuma Proving Ground, Arizona

Yuma Proving Ground (YPG) is located near the Arizona-California border, adjacent to the Colorado River, approximately 24 miles north of the city of Yuma, Arizona. Situated in the southwest portion of the state, the proving ground is in the heart of the great Sonoran desert and is 1,300 square miles (or 832,000 acres) in size (http://www.yuma.army.mil/location.html).

Yuma Proving Ground is the Army's desert environmental test center where testing of different types of ammunition and weapons is performed. Smoke and obscurant testing involving fog oil smoke, brass flakes, and graphite flakes has been conducted at YPG. Ammunition testing at YPG has also resulted in the potential for white phosphorous and terephelatic acid residues to be present in impact areas. A query for smokes and obscurants in YPG's Document Inventory Data Control (DIDC) indicates that tests involving smokes and obscurants are not conducted on a regular basis (e.g., every year). Three tests involving COCs were conducted in 2003, one test and one training event involving smokes were conducted in 2002, and one test was conducted in 2000. The records of studies involving smokes and obscurants on the DIDC list go back to 1967 and are documented in the Research, Development Test and Evaluation Activity Reports. Table 1 summarizes the use of smokes and obscurants at this installation.

The Arizona desert tortoise populations in and around YPG are not listed as threatened or endangered. However, under provisions of the ESA they are specifically identified as "Threatened by Similarity of Appearance," which means these tortoises aren't at risk to warrant listing, but it's not feasible for anyone to be able to distinguish between these and those from listed populations. The desert tortoise populations at Yuma live in inaccessible, north-facing slopes of higher terrain that is not used for mission use (personal communication, Valerie Morrill, Yuma Proving Ground, 20 February 2004). Therefore the exposure pathway for desert tortoise exposed to military-related compounds is likely to be incomplete.

Fort Irwin, California

Fort Irwin is the location of the National Training Center, the U.S. Army's heavy maneuver Combat Training Center (CTC). Fort Irwin is located approximately 37 miles northeast of Barstow, California in the High Mojave Desert midway between Las Vegas, Nevada and Los Angeles, California. The entire Fort encompasses approximately 636,000 acres of training area with the northern boundary less than 3 km from Death Valley National Monument. Desert hills and mountains surround the installation. The San Bernardino and San Gabriel mountains extend in an east-

west path 135 km southwest of Bicycle Lake. The Sierra Nevada Mountains, oriented north-to-south, are to the west. Elevations in excess of 10,000 feet (3,050 meters) are common in these ranges. Natural vegetation is sparse and consists of mesquite, creosote, yucca, and other low growing plants. Figure 2 presents the training areas and topography of the National Training Center at Fort Irwin.

Table 1 summarizes the use of smokes and obscurants at this installation. Table 3 summarizes the quantity of each type of ammunition used at Fort Irwin in 2002.

In this screening level assessment, the desert tortoise is the species of concern that will be evaluated for Fort Irwin. Figure 2 shows the location of desert tortoise critical habitat in relation to the training areas.

Fort Benning, Georgia

Fort Benning is located in the lower Piedmont Region of central Georgia and Alabama, 6 miles southeast of Columbus, Georgia. The Fort consists of approximately 182,000 acres. About 170,000 acres are in Muscogee and Chattahoochee Counties, Georgia, and another 12,000 acres are in Russell County, Alabama. The Chattahoochee River separates the Georgia and Alabama portions of the installation. Fort Benning is located at the intersection of two ecologically different regions: the Piedmont and East Gulf Coastal Plain. The result is a mosaic of Piedmont- and Coastal Plain-influenced habitats (U.S. Army 2001a). Figure 3 shows the geographic location and major features of Fort Benning.

Fort Benning is the home of the U.S. Army Infantry School and Center. In peacetime Fort Benning provides ranges and maneuver training areas to conduct initial entry training for infantry soldiers and officers; basic and advanced level noncommissioned officer and officer training courses; the U.S. Army's Airborne and Ranger schools; study, testing, and development of infantry doctrine, weapons systems, tactics, techniques and procedures (U.S. Army 2001a). Table 1 summarizes the use of S&Os at this installation. Table 4 summarizes the quantity of each type of ammunition used at Fort Benning in 2002.

An Integrated Natural Resources Management Plan (INRMP) for 2001-2005 has been completed for Fort Benning. The Fort is home to five Federally listed species and numerous species of conservation concern listed by either the Federal government or by the States of Georgia and Alabama. There are 96 species of conservation concern found on Fort Benning (4 amphibians, 8 birds, 7 fishes, 4 mammals, 4 mussels, 9 reptiles, and 60 plants). A species is listed as of conservation concern if it is listed by the U.S. Fish and Wildlife Service or by the states of Alabama or Georgia

as threatened (T) or endangered (E) or is otherwise identified as a candidate (C) species, species of special concern, state protected species, rare species, unusual species, or a watch-list species. The five Federally listed threatened and endangered species that occur at Fort Benning include the red-cockaded woodpecker (*Picoides borealis*) (E), wood stork (*Mycteria americana*) (E), Bald Eagle (*Haliaeetus leucocephalus*) (T), American alligator (*Alligator mississippiensis*) (T [S/A], in which S/A = due to similar appearance), and relict trillium (*Trillium reliquum*) (E). Endangered Species Management Plans (ESMPs) have been prepared for all of these species and are included as appendices to the INRMP (U.S. Army 2001a).

Potential exposure of red-cockaded woodpeckers to military-unique constituents at Fort Benning will be evaluated in this report. Fort Benning has one of the largest red-cockaded woodpecker populations in the southeastern United States with 186 active manageable clusters and 28 known, active unmanageable clusters (these clusters occur within impact areas) as of 1999. As shown in Figure 4, the population is well dispersed over the entire installation, except that no active clusters are located on the Alabama portion of the installation (U.S. Army 2001a). There are several Unique Ecological Areas identified in the INRMP (U.S. Army 2001a) that provide favorable roosting, nesting, and foraging habitat for red-cockaded woodpeckers due to the presence of longleaf pine forest. Specifically these are identified as:

- Lakeland Sandhills – longleaf savanna habitat in the central portion of the installation (portions of training compartments D14 and J7 as shown on Figure 4);
- Hastings Relict Sandhills – longleaf pine dominates the overstory in the northeastern portion of the installation (portions of compartments K11, K12 [minus Hastings Range], K13, K14, and K17);
- Malone Cane Brakes – large acreage of longleaf pine/mature mixed pine forests in the western portion of the installation (central portion of compartment M6);
- Slopes of Northern Affinities – longleaf pine sandhill communities in the upland areas at the east-central boundary of the installation (southern portion of compartment K20);
- Longleaf Pine Loamhills – southwest portion of the installation (portions of compartments A13, A14, A15, A16 [minus Griswold Range], and A17); and,
- Longleaf Pine Sandhills – northeast portion of the installation (portions of compartments K8 and K13).

Fort Gordon, Georgia

Fort Gordon is located just a few miles southwest of the city of Augusta, Georgia, and covers 56,000 acres. The post is located in Richmond County. The local area is referred to as the Central Savannah River Area, a group of 13 Georgia and South Carolina counties along the Savannah River which forms the state border. Figure 5 shows the training and impact areas at Fort Gordon.

The U.S. Army Signal Center is located at Fort Gordon. Fort Gordon's mission includes training, doctrine, force integration requirements, and mobilization. The Reserve Components Support Division at Fort Gordon provides year-round training for more than 60,000 reservists, as well as Army and Navy Reserve Officer Training Corps students. Fort Gordon is home to Dwight D. Eisenhower Army Medical Center, 93rd Signal Brigade, 513th MI Brigade, Gordon Regional Security Operations Center, and Navy, Marine, and Air Force Detachments (http://www.gordon.army.mil/cmdgrp/default.htm). Colored smokes (smoke grenades) and CS gas (grenades) are used at Fort Gordon in the training areas. A fog oil machine may have been used one time in one training area (TA 37a). There are 49 training areas at Fort Gordon. In the past 2 years of training at Fort Gordon, smoke has been used in all but seven training areas. Units typically use smokes in training exercises between 1 and 4 times per year (personal communication, Robert Drumm, Fort Gordon, 2004), although the installation was unable to quantify the amounts typically used. Table 1 summarizes the use of S&Os at this installation. Table 5 summarizes the quantity of each type of ammunition used at Fort Gordon during fiscal year (FY) 2002.

There are 31 target species at Fort Gordon (6 birds, 5 fish, 3 herps, 2 mammals, and 15 plants), as shown in Table 6. The target species rank information is based on information collected by the Georgia Natural Heritage Program. Four species are listed as endangered [bald eagle, wood stork, red-cockaded woodpecker, and sweet pitcherplant (*Sarracenia rubra* var. *rubra*) (State E)], and four more are listed as threatened [gopher tortoise (State T); rosemary (*Ceratiola ericoides*) (State T); Indian-olive (*Nestronia umbellula*) (State T); and Pickering's morning glory (*Stylisma pickeringii* var. *pickeringii* (State T)]. The target species that will be evaluated in this assessment are the red-cockaded woodpecker and gopher tortoise. As shown in Figure 5, red-cockaded woodpecker nest cavities and gopher tortoise burrows are located throughout the installation. According to installation training records for 2002, training occurred in most of the areas where red-cockaded woodpeckers and gopher tortoise are found.

Fort Stewart, Georgia

Fort Stewart is located in the Atlantic Coastal Plain of southeastern Georgia, 41 miles southwest of Savannah. It comprises portions of Long, Liberty, Tattnall, Bryan, and Evans counties. It is nearly rectangular, averaging 35 miles long by 18 miles wide, and contains 279,270 acres (MARCOA 1995). Fort Stewart rises from near sea level in the eastern portion of the installation to 183 feet along its western border. Most of the land is less than 33 feet above sea level with slopes less than 3 percent (The Nature Conservancy 1995). Figure 6 shows the training areas at Fort Stewart.

Fort Stewart and Hunter Army Airfield are the home of the 3rd Infantry Division (Mechanized). Several National Guard mechanized infantry units and U.S. Reserve units also train at Fort Stewart. Infantry, tanks, field artillery, helicopter gunnery, and small arms ranges can operate simultaneously at Fort Stewart throughout the year (Jones Technologies, Inc. and Gene Stout and Associates 2001a). Table 1 summarizes the use of smokes and obscurants at this installation. Table 7 summarizes the quantity of each type of ammunition used at Fort Stewart during 2002.

A multi-species Endangered Species Management Plan (ESMP) and INRMP have been prepared for Fort Stewart (Jones Technologies, Inc. and Gene Stout and Associates 2001a). There are four general types of ecosystems on Fort Stewart: sandhills, pine flatwoods, upland forests, and wetlands (Elfner 1996). Most soils on the two installations are classified as sandy and infertile. Fort Stewart is home to six species that are Federally listed as threatened or endangered: bald eagle, wood stork, red-cockaded woodpecker, eastern indigo snake (*Drymarchon corais couperi*), flatwoods salamander (*Ambystoma cingulatum*), and shortnose sturgeon (*Acipenser brevirostrum*). In addition, there are numerous species of concern listed by either the Federal government or by the state of Georgia (1 insect, 5 birds, 3 reptiles, 2 amphibians, and 9 plants). The gopher tortoise is on the Federal list of species of concern and is classified as threatened by the State of Georgia (Jones Technologies, Inc. and Gene Stout and Associates 2001a). Although not Federally listed in Georgia, this screening level assessment assumes that the gopher tortoise is potentially exposed to military-related compounds used at Fort Stewart. Gopher tortoises can be found in the dwarf oak forest (i.e., longleaf pine turkey oak) habitat in the sandhills areas at Fort Stewart. Characterized by deep sandy soils, the dwarf oak forest is an extremely dry forest of small deciduous oaks with a longleaf pine overstory. The sandhills occur along major streams and are remnants of Pleistocene barrier islands. The habitat is a fire maintained climax type, and in the absence of fire it will succeed to an oak woodland (Jones Technologies, Inc. and Gene Stout and Associates 2001a). Figure 6 depicts gopher tortoise populations in relation to training areas at Fort Stewart.

Fort Campbell, Kentucky

Fort Campbell lies on the Kentucky-Tennessee border between the towns of Hopkinville, KY, and Clarksvill, TN, about 60 miles northwest of Nashville, TN. The post encompasses 164 square miles (105,068 acres) in four counties: Montgomery and Stewart in Tennessee and Christian and Trigg in Kentucky. Approximately 12,000 acres of the installation have been developed into the cantonment or developed area while the remaining 93,000+ acres of the installation are dedicated to training and firing ranges (http://www.campbell.army.mil/overview.htm).

Fort Campbell is home to the 101st Airborne Division (Air Assault). The designation indicates that the helicopter is the primary means of transportation for the division (http://www.campbell.army.mil/overview.htm). Approximately 26,156 acres are designated small arms and artillery impact areas and 67,142 acres are available for military training activities. Table 1 summarizes the use of smokes and obscurants at this installation. Table 8 summarizes the quantity of each type of ammunition used at Fort Campbell in 2002.

Work by Fort Campbell has identified that at least 336 vertebrate species have been on the installation (Zirkle 1999). Forty species are listed by Federal or State agencies (Zirkle 1999). In this ecological risk assessment, potential exposure to two species listed as endangered, the Indiana bat and gray bat, will be assessed. Both bat species prefer to roost 4 km or less from water bodies in order to forage for aquatic insects. Numerous intermittent and permanent streams, two small impoundments (Lake Kyle in Stewart County and Lake Taal in Montgomery County), each containing more than 1 hectare in surface area, and numerous small ponds, marshy lowlands, and beaver swamps are present on the installation (Zirkle 1999). The biological assessment makes reference to areas with “high quality foraging habitat” for Indiana and gray bats.

Fort Knox, Kentucky

Fort Knox is located 30 miles southwest of Louisville in north-central Kentucky. The installation comprises 109,054 acres, or approximately 170 square miles, in Bullitt, Hardin, and Meade counties (http://www.knox.army.mil/garrison/dbos/fw/index.htm). Fort Knox is located in the Pennyroyal Plain area of the Mississippian Plateau Region and the Knobs area of the Outer Bluegrass Region. Small rounded uplands with moderately steep slopes characterize the Knobs area of the Outer Bluegrass region. Streams are numerous in this area and commonly run through steep valleys and gullies (BHE 2002).

Fort Knox is home of the U.S. Army Armor Center and the U.S. Army Recruiting Command. Fort Knox's mission is to provide high quality, realistic training for the Army, Air Force, Navy, Marine Corps, National Guard, Coast Guard, and Reserve Forces. Current land use on Fort Knox includes an approximately 7,000-acre cantonment area, approximately 101,000 acres of live-fire ranges, associated impact areas, and training/maneuver areas, and approximately 1,000 acres of recreation areas and managed lakes (Harland Bartholomew and Associates 1995). Table 1 summarizes the use of S&Os at this installation. Table 9 summarizes the quantity of each type of ammunition used at Fort Knox in 2002.

Several reports have been prepared for Fort Knox relevant to this ecological risk assessment (BHE 2001a, 2001b, 2002, Carter and Merritt 1995, Harland Bartholomew and Associates 1995). Approximately 60 percent (65,400 acres) of the installation is a diversified forest containing upland oak-hickory, poplar-beech-maple, oak-maple terrace, silver maple-cottonwood riparian forest, and pine plantations. These forested areas provide roosting habitat for bats. Ten caves are located in the western third of the installation (Carter and Merritt 1995). Surveys indicate at least three of the caves provide suitable habitat for summering or wintering bats. Species identified during cave surveys include Indiana bat, gray bat, little brown bat (*Myotis lucifugus*), the eastern pipistrelle (*Pipistrellus subflavus*), northern long-eared bat (*Myotis septentrionalis*), hoary bat (*Lasiurus cinereus*), and big brown bat (*Eptesicus fuscus*) (BHE 2001a, 2001b). Potential exposure of the Indiana bat and gray bat to obscurants and military-unique compounds is assessed in this report. Gray bats can be found roosting and foraging along waterways at Fort Knox. Indiana bats are expected to be found all over the installation where there are loose bark sycamore trees. There is a 1,400-acre Indiana bat management area in the northeast portion of the installation (personal communication, Gail Pollock, Fort Knox, 2004).

Fort Polk, Louisiana

Fort Polk covers 198,963 acres in Vernon County in west-central Louisiana. Almost half of the lands on post (98,125 acres) belong to the United States Forest Service as part of the Kisatchie National Forest (http://www.fs.fed.us/r8/kisatchie/calcasieu-rd/vernon/index.htm).

Fort Polk is currently the home of the Joint Readiness Training Center (JRTC), the 2nd Armored Calvary Regiment, the FORSCOM Redistribution Center (operated by Martin-Lockheed), and the garrison's Warrior Brigade (http://www.jrtc-polk.army.mil/). Table 1 summarizes the use of smokes and obscurants at this installation. Table 10 summarizes the quantity of each type of

ammunition used at Fort Polk in 2002. Some evaluation of U.S. Army potential training impacts at Fort Polk has been conducted (Wagner 1999).

Camp Shelby, Mississippi

National Guard and Reserve units from all over the country train at Camp Shelby, which is a state-owned and -operated facility. The Camp Shelby Joint Forces Training Center, encompassing over 129,675 acres (525 square kilometers), is located in portions of Perry and Forrest counties, in south Mississippi. The training site consists of a mix of State, DoD, and approximately 110,000 acres of U.S. Forest Service land in the DeSoto National Forest (http:www.epa.gov/fedrgstr/EPA-IMPACT/2003/September/Day-04/i22475.htm). Figure 7 shows the military training compartments at Camp Shelby.

There are two major areas with dedicated impact areas at Camp Shelby: 202 East and 201 West. The area called 202 East is an aircraft firing/bombing range and 201 West is a helicopter gunnery range. Several small arms firing ranges are located around the 14,000-acre West impact area. Table 1 summarizes the use of smokes and obscurants at this installation. Table 11 summarizes the quantity of each type of ammunition used at Camp Shelby in 2002.

Camp Shelby is located in the Lower Coastal Plain ecoregion. The terrain consists of gently rolling hills, longleaf pine forest, mixed hardwood pine ridges, and deciduous hardwood in wetland areas. A number of streams drain the impact area at Camp Shelby, and riparian wetlands are common along these streams (http://www.globalsecurity.org/military/facility/camp-shelby.htm). Two Federally listed species are present at Camp Shelby: the gopher tortoise and Louisiana quillwort (*Isoetes louisianensis*). Training Area 44 has been designated as a gopher tortoise refuge. Off-road maneuvers are prohibited, but there are some firing points within that training area. Training Area 44 is a preferred habitat for gopher tortoise. However, as shown in Figure 7, there is gopher tortoise habitat in other training areas on post. According to personnel at Camp Shelby, gopher tortoises apparently prefer the ridges, especially in areas that are burned regularly, where the vegetation is low to the ground. The Louisiana quillwort is a Federally listed (E) wetland plant species present at Camp Shelby. The Camp also manages red-cockaded woodpecker habitat (i.e., mature longleaf pines), but red-cockaded woodpecker colonies have not been noted there. There are several gopher tortoise burrows within the small arms impact area and 202 East that could potentially be exposed to military-related COCs. This screening level assessment evaluates potential exposure of the gopher tortoise to military- related COCs used or present at Camp Shelby.

Fort Leonard Wood, Missouri

Fort Leonard Wood is located in Pulaski County, Missouri. The installation covers approximately 62,208 acres in the Ozarks, approximately 1150 feet above mean sea level (http://www.globalsecurity.org/military/facility/fort-leonard-wood.htm). The terrain is mostly flat with some gently rolling hills. MANSCEN (Maneuver Support Center), the U.S. Chemical, Engineer, and Military Police Schools, the Center of Excellence for Homeland Defense, and other units are located at Fort Leonard Wood. Types of training conducted at this installation include: engineer basic and advanced individual training, basic combat training, chemical training, military police training, non-commissioned officer training, and training in 14 different military occupational specialties including Motor Transport Operator Course, construction equipment operators, plumbing, technical drafting, material quality specialists, construction surveyors, and demolition (http://www.wood.army.mil). As part of the chemical training program, soldiers learn how to use a fog oil generator. Table 1 summarizes the use of S&Os at this installation. The table includes the amount of fog oil, generator type, and frequency information for items used in fog oil generator equipment training. Four training areas are currently approved for fog oil use under the air permit, but only TA401 is used (except for a couple of times in September 2002). Table 12 summarizes the quantity of each type of ammunition used at Fort Leonard Wood in 2002. Data was available for September through December of 2002 only. Range Control staff said that the estimates for September through December represent about 1/3 of the training done throughout the year. The annual estimate was obtained by multiplying the September through December estimates by three.

This screening level assessment evaluates potential exposure of the Indiana bat and gray bat to military-related compounds used at Fort Leonard Wood.

Fort Bragg, North Carolina

Fort Bragg is located 10 miles northwest of Fayetteville, North Carolina, in the Sandhills Region. It covers 153,562 acres and has range and training areas primarily within 4 counties: Hoke, Cumberland, Harnett, and Moore. Camp Mackall, within Scotland, Moore, and Richmond counties, is 40 miles west of the Fort Bragg cantonment and contains 7,935 acres (Jones Technologies, Inc. and Gene Stout and Associates 2001b).

The mission at Fort Bragg is to maintain the XVIII Airborne Corps as a strategic crisis response force, manned and trained to deploy rapidly by air, sea, and land anywhere in the world. The Advanced Airborne School is also located at Fort Bragg

(http://www.bragg.army.mil/18abn/). Armor, artillery, and mechanized infantry reserve units also use Fort Bragg for inactive duty training and annual training (Jones Technologies, Inc. and Gene Stout and Associates 2001b). The Range and Training Area is geographically divided into five areas. From east to west these five areas are the Northeast Area (separated from other training by the Cantonment), the Greenbelt, the Northern Training Area (including Overhills), the primary maneuver training area (extending west from the Greenbelt and Cantonment) and Camp Mackall. Ranges and impact areas are located in the center of Fort Bragg and consist of some 33,040 acres and are described as follows:

- Manchester Impact Area (2,780 acres) is located adjacent to the northeastern part of the primary maneuver area and 25 ranges are located along the periphery of this impact area.
- The MacRidge Impact Area (10,436 acres) is located in the east-central part of the primary training area and contains the largest number of ranges. Rifle marksmanship training and qualification ranges, small arms ranges, and mortar, artillery, and tank firing positions ring the periphery of MacRidge, along with two explosive demolition areas.
- Coleman Impact Area (13,143 acres) is the largest impact area on the reservation and is located near the center of the primary maneuver area. Weapons used range from small arms and hand grenades to the 203-mm howitzer, as well as Air Force aircraft bombing and strafing and several types of missiles.
- McPherson Impact Area (6,671 acres) is located in the western end of the reservation in an irregular configuration. Weapons are limited due to the area's shape, but activities are similar to those listed for the Coleman Impact Area, with the exclusion of direct fire artillery, tank firing, and Stinger missile. Compared to other impact areas, there are few ranges around the periphery of McPherson (Jones Technologies, Inc. and Gene Stout and Associates 2001b).

Table 1 summarizes the use of smokes and obscurants at this installation. Table 13 summarizes the quantity of each type of ammunition used at Fort Bragg in 2002.

An INRMP for 2001-2005 has been completed for Fort Bragg (Jones Technologies, Inc. and Gene Stout and Associates 2001b). Almost half the installation, 72,000 acres, is forested by longleaf pines (*Pinus palustris*) making it the dominant canopy tree species on post. Much of the forest on Fort Bragg contains wiregrass (*Aristida stricta*) as the primary ground cover. When found together, these two species make up the major components of the longleaf pine/wiregrass ecosystem, which is characterized by widely spaced mature pines in the canopy and a scattered mix of successional stages, a clear mid- and understory, and a ground cover composed mainly of wiregrass with numerous other species intermingled. The five Federally listed en-

dangered species found on Fort Bragg/Camp Mackall are: American chaffseed (*Schwalbea americana*), Michaux's sumac (*Rhus michauxii*), red-cockaded woodpecker (*Picoides borealis*), rough-leaved loosetrife (*Lysimachia asperulaefolia*), and the butterfly called St. Francis Satyr (*Neonympha mitchellii francisci*). Additionally, Fort Bragg is home to many species of Federal concern and/or state-listed (endangered, threatened, species of concern) biota. This list includes: Bachman's sparrow (*Aimphila aestivalis*), loggerhead shrike (*Lanius ludovicianus*), star-nosed mole (*Condylura cristata*), tiger salamander (*Ambystoma tigrinum*) and dwarf salamanders (*Eurycea quadridigitata*), southern hognosed snake (*Heterodon simus*), Atlantic pigtoe (*Fusconaia masoni*), Venus flytrap (*Dionaea muscipula*), sandhills milkvetch (*Astragalus michauxii*), sandhills pyxie-moss (*Pyxidanthera barbulata* var. *brevifolia*), Pickering's dawnflower (*Stylisma pickeringii* var. *pickeringii*), and dwarf bladderwort (*Utricularia olivacea*) (http://www.bragg.army.mil/esb/longleaf_ecosystem.htm).

This screening level assessment evaluates potential exposure of the red-cockaded woodpecker to military-related COCs used at Fort Bragg. The red-cockaded woodpecker is considered to occur throughout Fort Bragg due to the presence of pine forest throughout most of the installation (Map 3.4.2.2.2 in the INRMP). There is essentially one red-cockaded woodpecker cluster for each square kilometer of maneuver land on Fort Bragg and Camp Mackall. Fort Bragg and Camp Mackall sub-populations occur within the North Carolina Sandhills physiographic province. The INRMP indicates that the Greenbelt is considered an area of special concern for the red-cockaded woodpecker. The Greenbelt includes 6,329 acres, is approximately 6.6 miles in length, and ranges from 0.26 to 2.2 miles wide. Training areas in the Greenbelt include a landing zone, compass courses, CS chamber, and defensive driving course (Jones Technologies, Inc. and Gene Stout and Associates 2001b). The exact location of red-cockaded woodpecker clusters in areas where ammunition and S&Os are likely to be used is unclear.

Fort Sill, Oklahoma

Fort Sill's 94,000 acres of land is located in southwest Oklahoma, the heart of "Oklahoma's Great Plains" country. It is 90 miles southwest of Oklahoma City, the state capitol, and 50 miles north of Wichita Falls, Texas on Interstate 44. The post is adjacent to and just north of the city of Lawton (http://www.globalsecurity.org/military/facility/fort-sill.htm).

The U.S. Army's Field Artillery School is located at Fort Sill. Fog oil obscurant smoke is not used at Fort Sill, however Table 1 summarizes the use of other S&Os

at this installation. Table 14 lists the quantity of each type of ammunition used at Fort Sill in 2002.

Black-capped Vireo nests have been located in the following Training Areas: 8, 11, 12, 13, 14, 17, 24, 25, and 43. Of these areas Fort Sill provided the following information about training activities in those areas:

- TA 8 is rarely used (people might drive through there occasionally);
- TA 11, 12, 13, 14, and 43 are mountainous/rocky areas used for navigation training (map and compass);
- TA 17 is rarely used because it is remote;
- TA 24 is sometimes used, but mostly blanks are fired. There are no ranges in this Training Area;
- There are no ranges in TA 25. Units fire over TA 25, but there isn't much activity in the training area itself.

Therefore, the exposure pathway for black-capped vireo exposed to military-related COCs Fort Sill is likely to be incomplete.

Fort Jackson, South Carolina

The U.S. Army Training Center at Fort Jackson is in central South Carolina in Richland County adjacent to and part of the city of Columbia. Fort Jackson encompasses 52,301 acres of land including over 50 ranges and field training sites. Fort Jackson is on the northwestern edge of the Atlantic Coastal Plain Province, a region of low to moderate relief and gently rolling plains, known as the Sand Hills. Gently to moderately rolling, moderately dissected high plains occupy most of Fort Jackson. These high plains are interrupted by the nearly flat alluvial plains of Gills, Cedar, and Colonels creeks and their tributaries, and an irregularly distributed, gently sloping, low relief area in the central portion of the installation near the headwaters of Cedar Creek (Parsons Harland Bartholomew and Associates, Inc. 2000). Figure 8 shows the training and impact areas at Fort Jackson.

The U.S. Army Basic Combat Training Center of Excellence is located at Fort Jackson. The installation trains about 45,000 soldiers in Basic Combat Training and Advanced Individual Training each year. In addition, Fort Jackson supports over 60,000 Reserve, South Carolina Army National Guard (SCARNG), and Reserve Officers Training Course personnel annually on its weapons ranges and training lands. The SCARNG is licensed to use 14,832 acres for maneuver and field training requirements in the southeastern corner of Fort Jackson (McCrady Training Center). Fort Jackson has 143 alphanumeric training areas, which encompass about 37,735 acres. Twelve of these areas (training area 6A-6I and 7A-7C, totaling 4,857

acres) are part of the West Impact Area and are not available for maneuver or field training exercise (FTX). The East Impact Area (Artillery Impact Area) includes about 5,250 acres near the center of the installation. The East Impact Area is the established impact area for mortar and artillery weaponry training; an Engineer Demolition Site is also located within the East Impact Area. Maneuver, FTX, or any other land-based training is prohibited within the East Impact Area (except at established ranges), and unauthorized access into the East Impact Area is prohibited due to the presence of unexploded ordnance that presents a safety hazard. The SCARNG is licensed to use training areas TA 21 and TA 23 through TA 35. SCARNG training activities are similar, so impact to natural resources are the same as for other field training exercises at Fort Jackson (U.S. Army 2001b). Table 1 summarizes the use of smokes and obscurants at this installation. Table 15 lists the quantity of each type of ammunition used at Fort Jackson in 2002.

In this screening level assessment potential exposure of the red-cockaded woodpecker to military-related COCs used at Fort Jackson is evaluated. Fort Jackson has completed a Biological Assessment on the effects of military training activities on listed species (U.S. Army 2001b). As with all other Army installations, an INRMP has also been developed.

Forest cover constitutes the primary cover type with wetland communities occurring adjacent to streams and drainages. In general, Fort Jackson can be classified into five primary terrestrial vegetative types: pine, pine/upland hardwood, upland hardwood, bottomland hardwood, and open field. Field investigations and surveys have identified over 750 species of flora on the installation. Two Federally listed endangered plant species, rough-leaved loosestrife and smooth coneflower (*Echinacea laevigata*) occur on Fort Jackson. Various inventories have confirmed the occurrence of 30 mammals, 109 birds, 24 fish, 68 reptile and amphibian species, and 45 invertebrate species on the installation. One Federally listed endangered animal, the red-cockaded woodpecker, is a resident of Fort Jackson. The Bald Eagle (listed as threatened), is a transient visitor to the installation. Fort Jackson provides habitat for four rare animal species that are not currently listed as threatened or endangered: the southeastern myotis (*Myotis austroriparius*), Rafinesque's big eared bat (*Plecotus rafinesquii*), loggerhead shrike, and Bachman's sparrow (Parsons Harland Bartholomew and Associates, Inc. 2000). Longleaf pine forest areas on the installation provide habitat for red-cockaded woodpeckers. There are 25 or 26 active clusters located primarily within the southeastern quadrant of the installation and eight active clusters in the East Impact Area. Figure 8 shows the location of red-cockaded woodpecker cavities in relation to training and impact areas at Fort Jackson.

Camp Bullis, Texas (and Fort Sam Houston, Texas)

Camp Bullis is located 17 miles northwest of San Antonio in Bexar County. All training for soldiers stationed at Fort Sam Houston takes place at Camp Bullis. Camp Bullis has almost 28,000 acres of maneuver areas and firing ranges (DoD 2005). Figure 9 shows the manuever areas at Camp Bullis.

The U.S. Army Medical Department (AMEDD) Center and School is located at Fort Sam Houston. Camp Bullis is used for annual training of soldiers at the AMEDD Center and School and the Joint Medical Readiness Training Center (JMRTC) at Fort Sam Houston as well as thousands of Army Reserve and National Guard soldiers. Training areas at Camp Bullis include: Military Operations in Urban Terrain (MOUT) Site; Combat Medic Training Park; Tactical Vehicle/Driver Training Course; Nuclear, Biological, Chemical Confidence Chamber; Parachute Drop Zone (DZ Hall); Litter Obstacle Course; Black Jack Village; Bivouac Area and Training Site; Combat Assault Landing Strip (CALS); and numerous small arms firing ranges. Table 1 summarizes the use of S&Os at this installation. The fog oil amount, generator type, and frequency information are used when training medical students in triage where there is limited visibility. Table 16 summarizes the quantity of each type of ammunition used at Camp Bullis in 2002.

Two Federally listed endangered bird species, the Golden-checked Warbler and the Black-capped Vireo, and two endangered cave invertebrate species (*Rhadine exilis* and *R. infernalis*) are present at this installation. Figure 9 shows the location of black-capped vireo and golden-cheeked warbler habitat in relation to maneuver areas at Camp Bullis.

Fort Hood, Texas

Fort Hood is a 217,337-acre armor training installation located in central Texas, approximately 60 miles north of Austin and 160 miles south of Dallas/Fort Worth (http://www.globalsecurity.org/military/facility/fort-hood.htm). Fort Hood is located in Bell and Coryell counties, adjacent to the city of Killeen. Located at the northern extent of the Edward's Plateau, the topography consists of numerous steep sloped hills and ridgelines above flat to gently rolling plains (Hayden et al. 2001). Figure 10 shows the military training compartments at Fort Hood.

Fort Hood stations two armored divisions and supports training for an armored division of the National Guard. There are 138,948 acres of maneuver areas and 50 live-fire training ranges at Fort Hood. Table 1 summarizes the use of S&Os at this

installation. Table 17 summarizes the quantity of each type of ammunition used at Fort Hood in 2002.

An ESMP for fiscal years 2001-2005 has been prepared for Fort Hood (Hayden et al. 2001). Data obtained from the Army's Land Condition Trend Analysis (LCTA) Program at Fort Hood show that the installation is divided mainly into perennial grassland and woodland community types. Most of the grasslands exhibit a dense or closed vegetative cover and are dominated by Texas wintergrass (*Stipa leucotricha*) and prairie dropseed (*Sporobolus heterolepis*). Broadleaf woodlands comprise about 39 percent of LCTA woodland sites and typically are dominated by oaks. Coniferous and mixed woodlands comprise 61 percent and are dominated by Ashe juniper (*Juniperus ashei*) or a mixture of juniper and various oaks (Hayden et al. 2001).

Two Federally listed endangered bird species are present at Fort Hood: the black-capped vireo and the golden-cheeked warbler. Additional listed and formerly listed species, such as the bald eagle, whooping crane (*Grus americana*) and peregrine falcon (*Falco peregrinus*), occur as transient species on Fort Hood. Alabama croton (*Croton alabamensis*) is a plant species of concern at Fort Hood, but known populations are in locations where virtually no military training is conducted and/or where training is restricted under the Fort Hood Endangered Species Training Guidelines. Monitoring of cave-adapted species is also included in the ESMP for Fort Hood (Hayden et al. 2001). Potential exposure of the black-capped vireo and the golden-cheeked warbler to obscurants and military-unique compounds will be assessed in this report. Warblers on Fort Hood occupy habitats consisting of Ashe juniper and a variety of oak species. Black-capped vireo habitat at Fort Hood consists of low hardwood scrub patches resulting from accidental fires or mechanical clearing related to military training. Nest parasitism of black-capped vireo by brown-headed cowbirds (*Molothrus ater*) is of concern at this installation (Hayden et al. 2001). Warbler and vireo habitats at Fort Hood are shown in Figure 11.

Wind Rose Information

Smoke and obscurants are released into the atmosphere and move in accordance with local atmospheric and other conditions. Figure 12 provides wind rose data for each of the installations. The wind rose provides information about the distribution of wind speed and the frequency of varying wind directions. The wide arc shows how long the wind has been blowing from that direction expressed as a percentage, while the narrower, filled arc shows the wind strength from that direction. If the green, filled arc is longer than the wide arc, the wind speed was above average, and if it's shorter, the wind speed was below the average. For example, for Fort Rucker, Alabama, the wind blew from the north approximately 20 percent of the time at a

higher-than-average wind speed (in this case approximately 4.5 kph). This figure can be used to determine, on average over the course of a year, what direction the wind blow from and at what speed. This is useful in terms of gauging the direction in which the plumes and clouds formed from the smokes and obscurants are likely to go, and at what speeds.

It was beyond the scope of this report to determine site-specific meteorology for each of the installations; however, this information is available (in many cases specific to the installation rather than from an airport or other nearby location) and could be used to conduct installation-specific modeling of fog oil, other obscurant and signal smoke, and other chemical compounds (e.g., CS) dispersion in the environment.

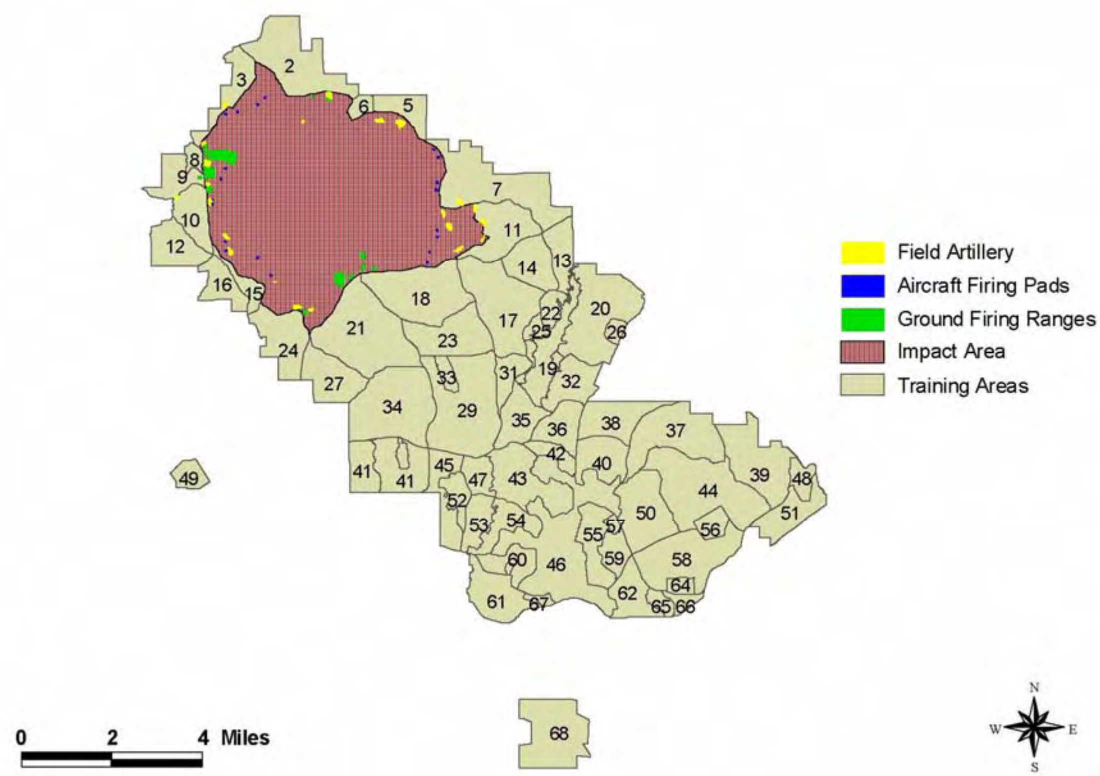

Figure 1. Military training compartments at Fort Rucker, Alabama.

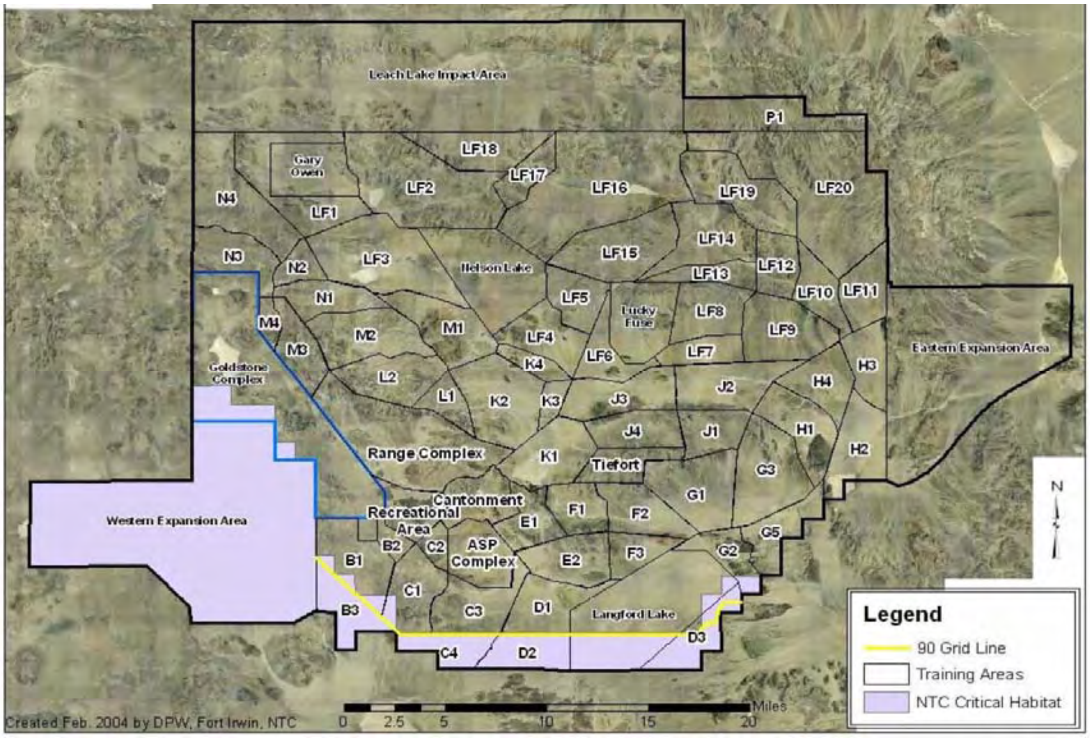

Figure 2. Training areas and desert tortoise critical habitat at Fort Irwin, National Training Center, California.

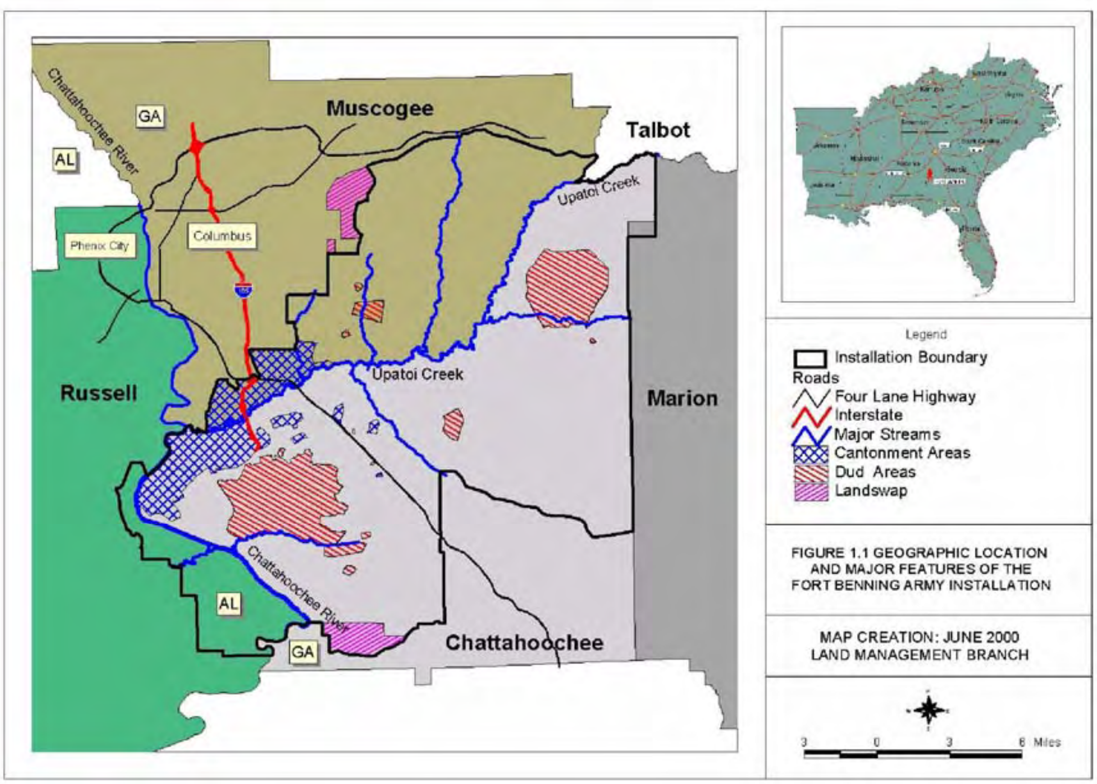

Figure 3. Geographic location and major features at Fort Benning, Georgia.

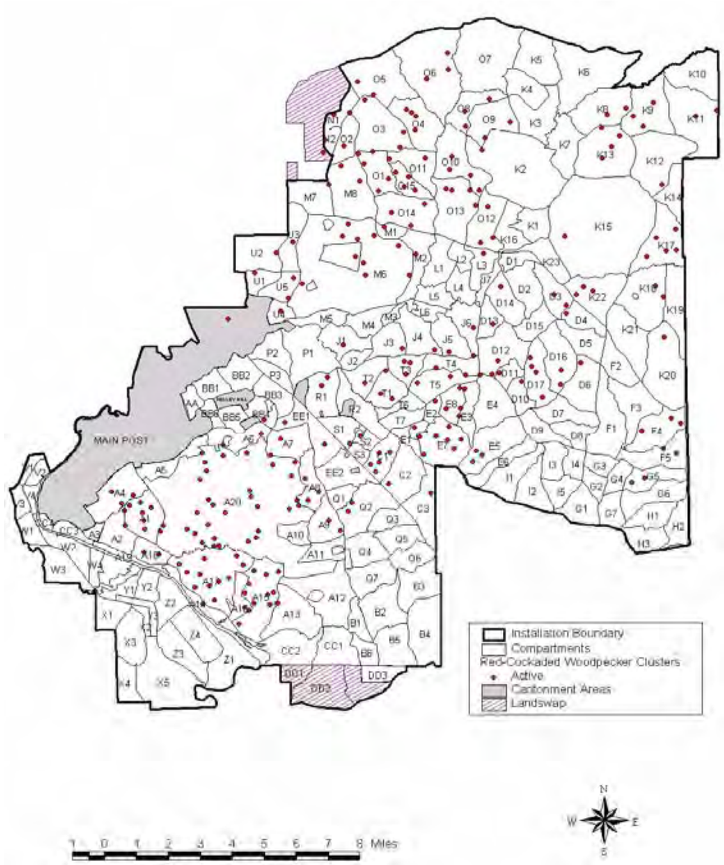

Figure 4. Active red-cockaded woodpecker clusters at Fort Benning, Georgia.

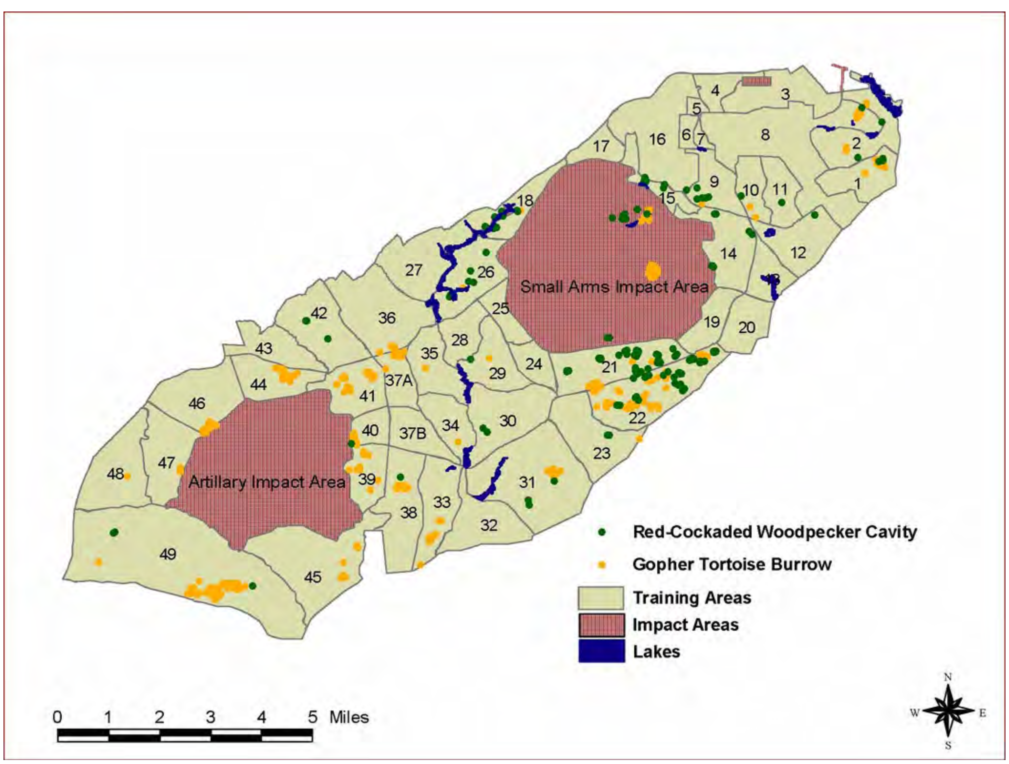

Figure 5. Training areas and locations of threatened and endangered species at Fort Gordon, Georgia.

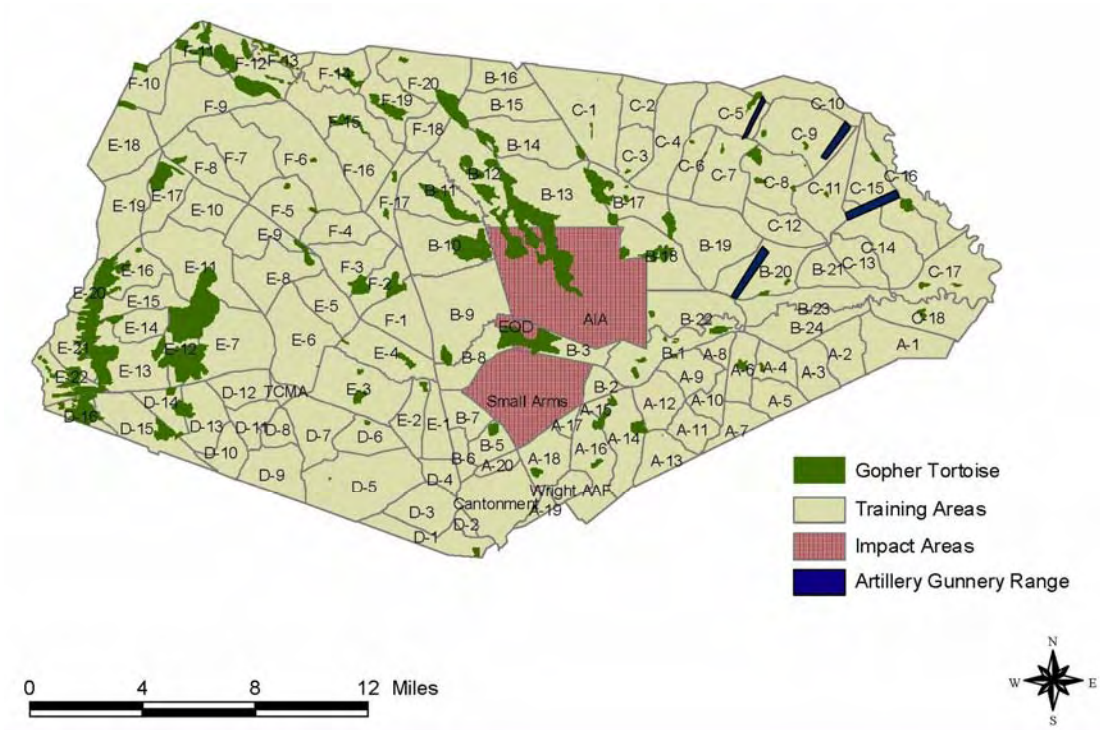

Figure 6. Training areas and gopher tortoise populations at Fort Stewart, Georgia.

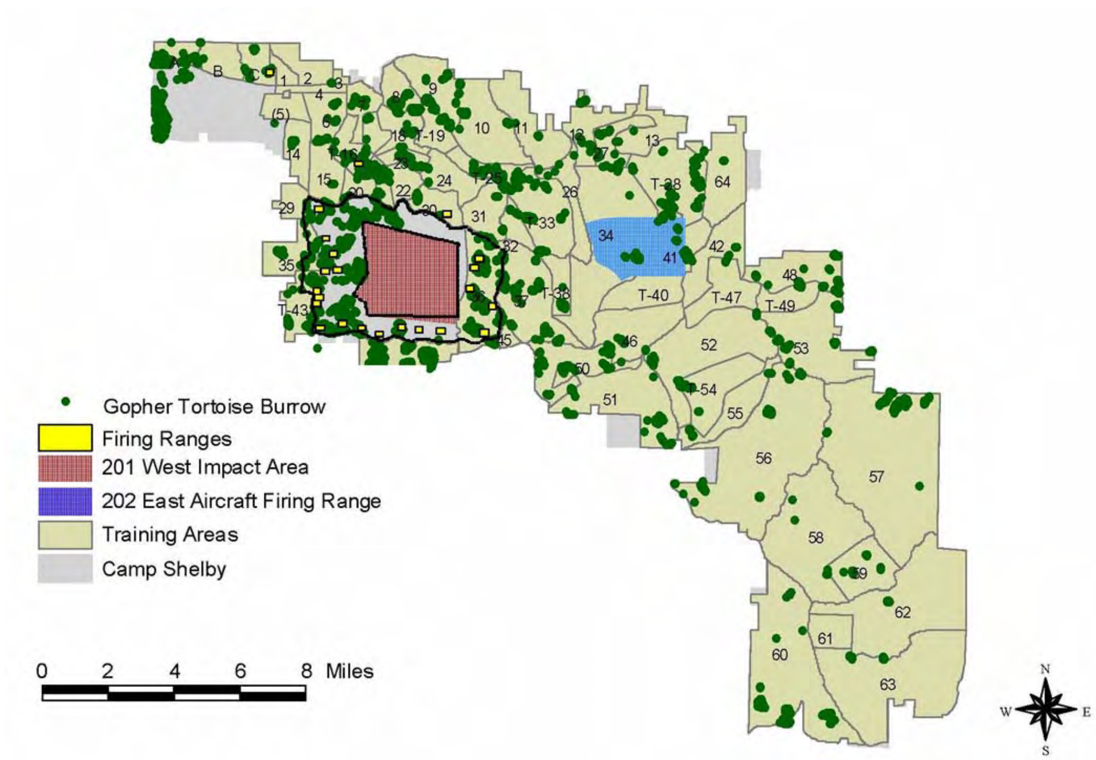

Figure 7. Military training compartments and gopher tortoise burrow locations at Camp Shelby, Mississippi.

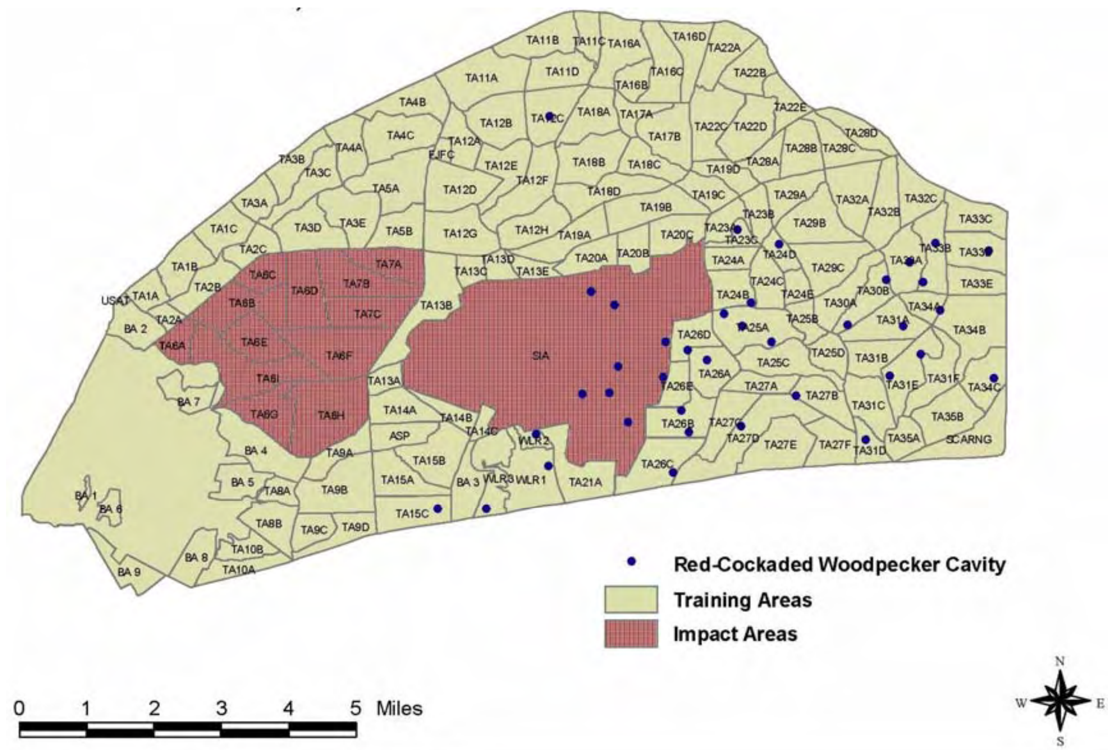

Figure 8. Training areas and red-cockaded woodpecker cavities at Fort Jackson, South Carolina.

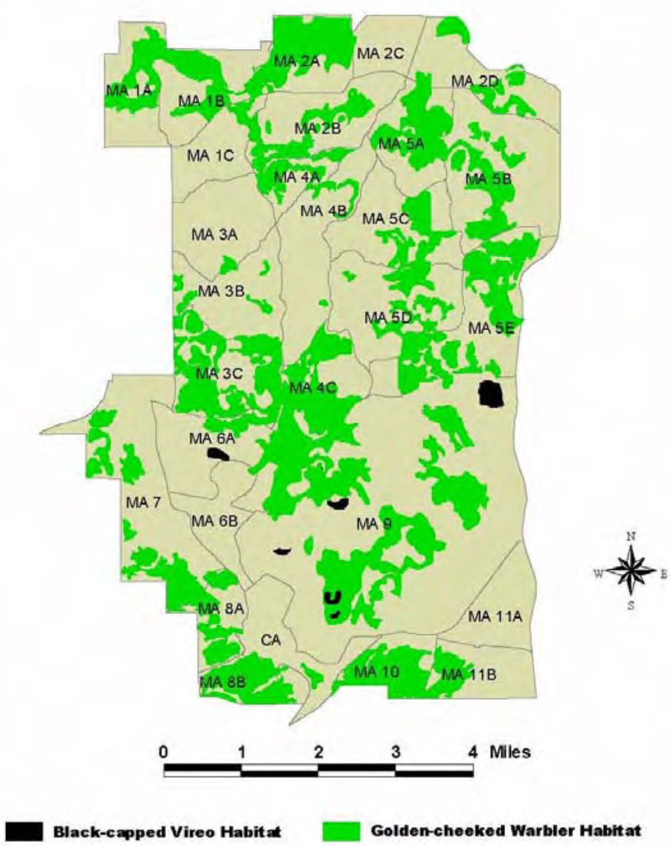

Figure 9. Maneuver areas and endangered avian species habitats at Camp Bullis, Texas.

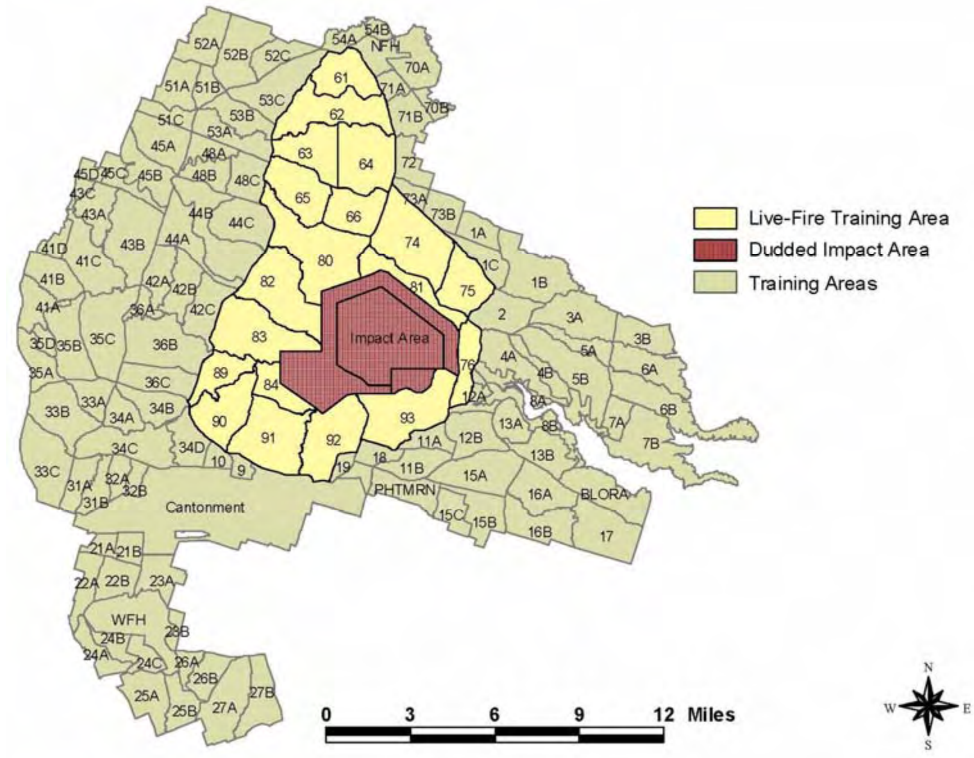

Figure 10. Military training compartments at Fort Hood, Texas.

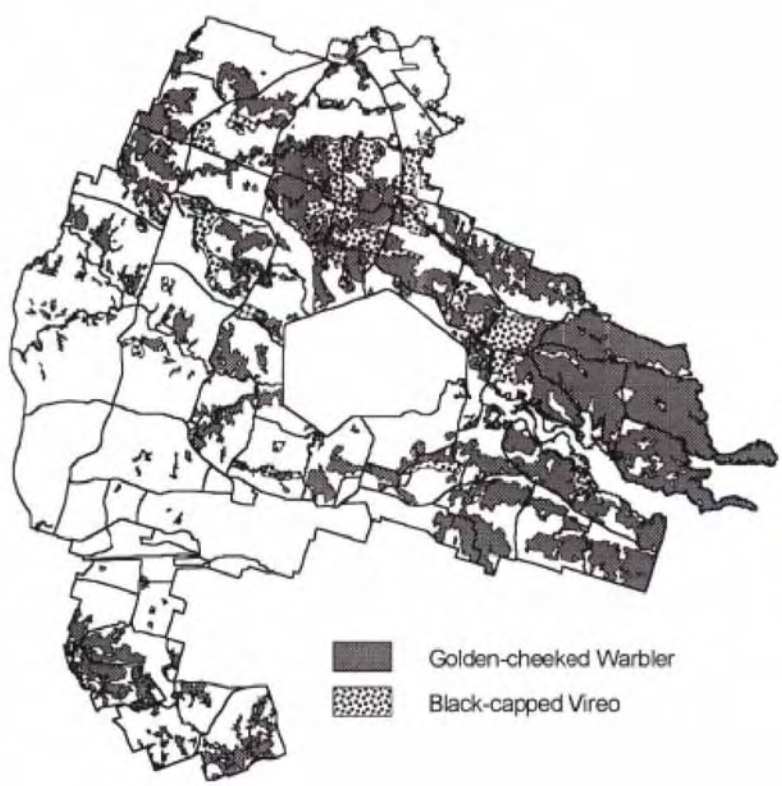

Figure 11. Distribution of golden-cheeked warbler and black-capped vireo habitat at Fort Hood, Texas.

Source: Hayden et al, 2001, Endangered Species Management Plan for Fort Hood, Texas.

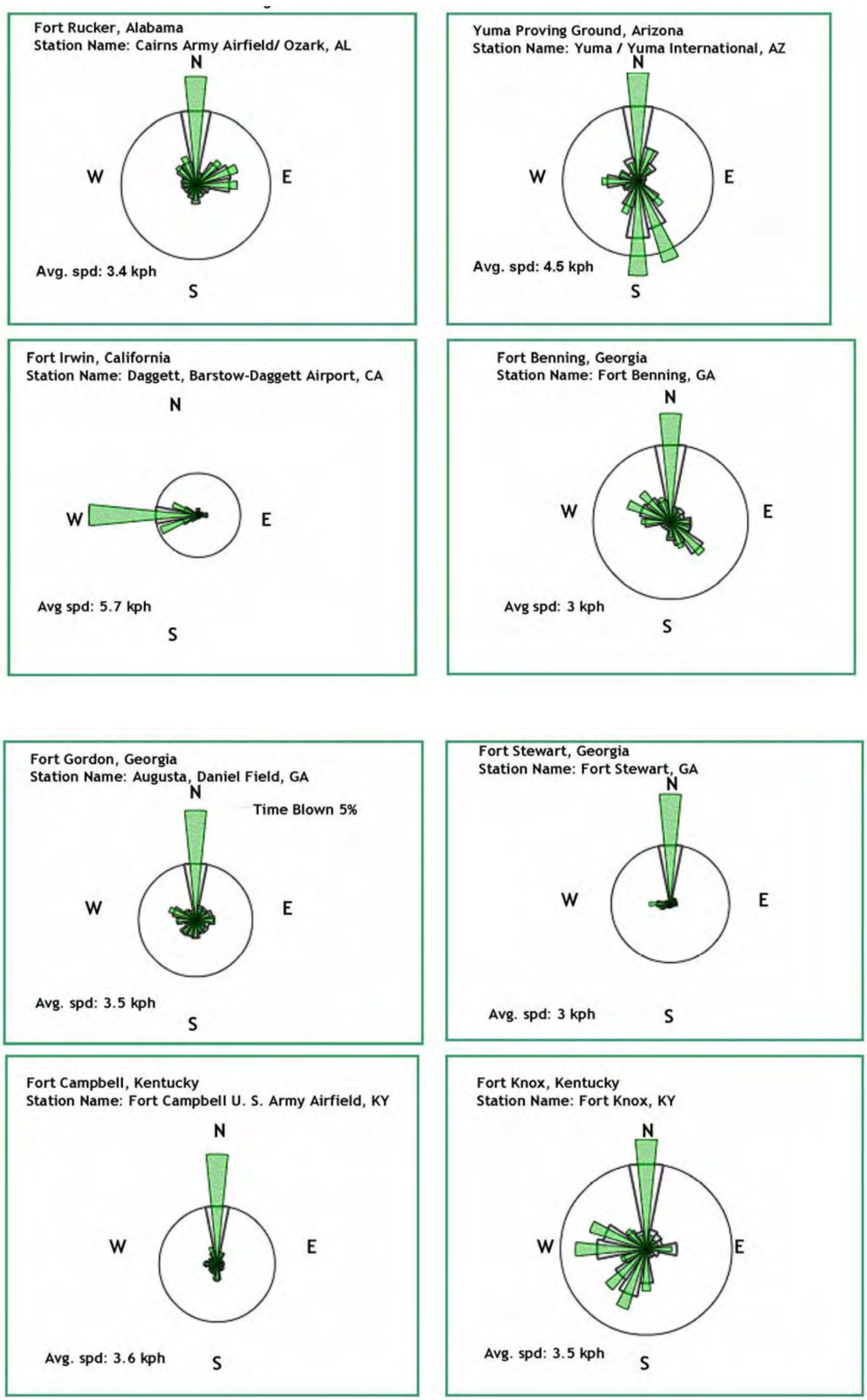

Figure 12. Wind rose data for the installations.

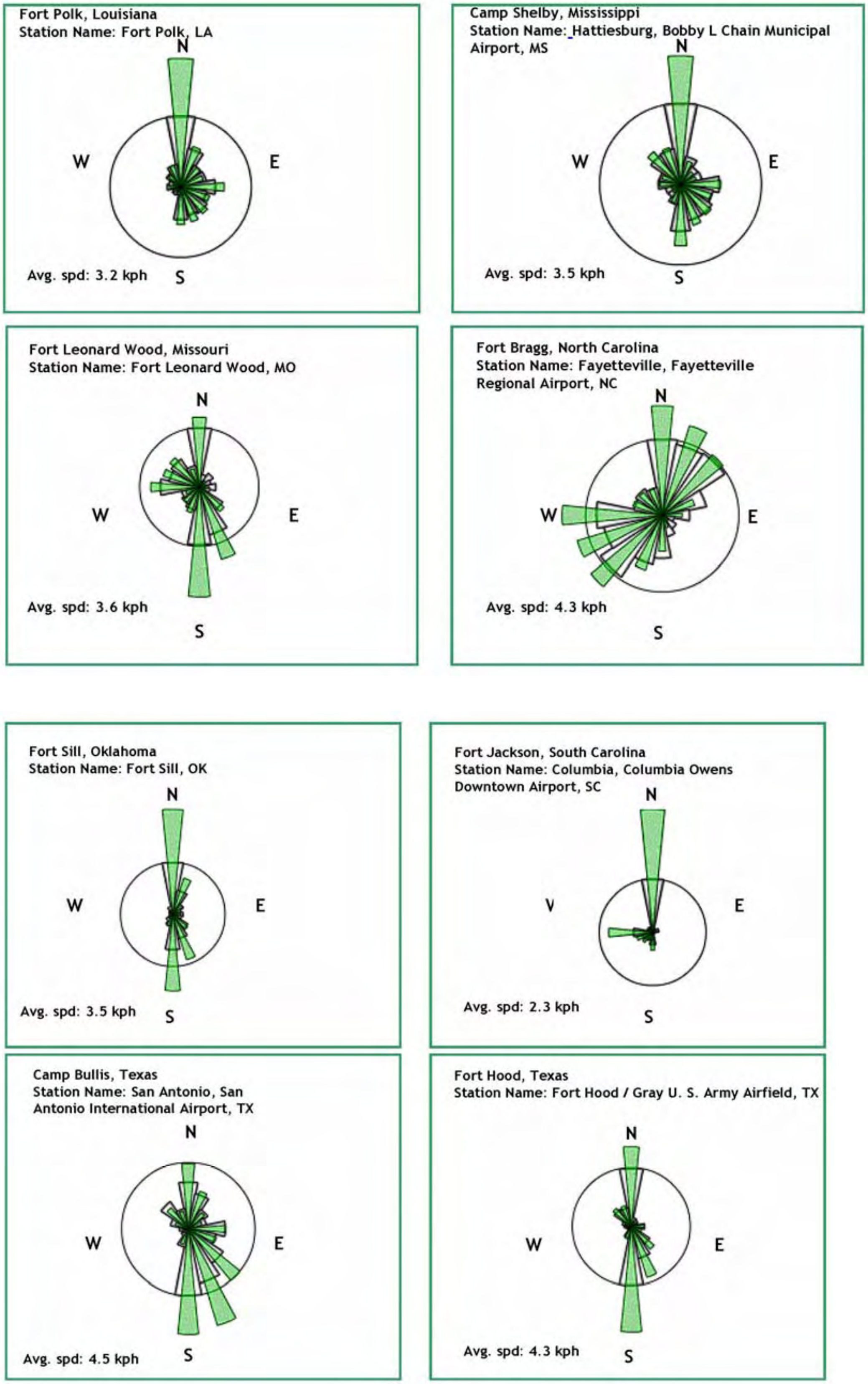

Figure 12. Continued.

Table 1. Summary of smoke and obscurant use at select Army installations.

Installation Name	Use fog oil? [3]	Use graphite flakes? [3]	Use brass flakes? [3]	Use colored smoke? [4]	Use HC smoke? [4]	Use WP smoke? [4]	Amount of fog oil used per year	Type of fog oil generator used	Day/year fog oil used	Hours/day fog oil used	Frequency of graphite use with fog oil
Ft. Rucker	No	No	No	Yes	No	No	NA	NA	NA	NA	NA
Yuma Proving Ground	Yes, test	Yes, test	Yes, test	Yes	NI	Yes, test	NA	M3A3, M1059, M56, M58 (tested)	NA	NA	NA
Ft. Irwin	Yes	No	No	Yes	Yes	Yes	55 gallon (April ' 02 - Jan ' 03)	M56, M58	92	4 hour total time avg. (1 hour avg. per generator)	NA
Ft. Stewart	NI	NI	NI	Yes	Yes	Yes	NI	NI	NI	NI	NI
Ft. Benning	Yes (>2 years ago)	No	No	Yes	Yes	Yes	NI	NI	NI	NI	NA
Ft. Gordon	Yes	NI	NI	Yes	Yes	No	NI	NI	NI	NI	NI
Ft. Campbell	Yes	Yes	No	Yes	Yes	Yes	NI	M56	4	1	100%
Ft. Knox	Yes	No	No	Yes	No	Yes	55 gallons (used in 2001)	M56 used in 2001, M157/A2 has also been used before	1	2	NA
Ft. Polk	Yes	No	No	Yes	Yes	Yes	NI	NI	NI	NI	NA
Ft. Leonard Wood [1]	Yes	No	No	Yes	Yes	No	36,522 gallons	M157, M56/58	237	2.6 (M157), 1.3 (M56/58)	NA
Camp Shelby	Yes	No	No	Yes	No	Yes	800 gallons	M1059	11	NI	NA

Installation Name	Use fog oil? [3]	Use graphite flakes? [3]	Use brass flakes? [3]	Use colored smoke? [4]	Use HC smoke? [4]	Use WP smoke? [4]	Amount of fog oil used per year	Type of fog oil generator used	Day/year fog oil used	Hours/day fog oil used	Frequency of graphite use with fog oil
Ft. Bragg	Yes	Yes	No	Yes	Yes	Yes	NI	M3A3 mechanical smoke generator, M52 helicopter smoke system, and the M157 vehicle mounted	< 25	1-2	less than half the time
Ft. Sill	No	No	No	Yes	Yes	Yes	NA	NA	NA	NA	NA
Ft. Jackson	Yes	No	No	Yes	No	Yes	330 gallons	M56	NI	up to 1.5	NA
Camp Bullis [2]	Yes	Yes	No	No	No	No	1/2 cup	Rosco 1500	6	2	0%
Ft. Hood	Yes	NI	No	Yes	Yes	Yes	1760 gallons purchased in CY 2003	M56 & M58	NI	NI	NI
Ft. Sam Houston	All training conducted at Camp Bullis		NA	NA	NA	NA	NA	NA	NA	NA	NA

NA = Not applicable.

NI = No information available (colored smoke info comes out of munitions database).

HC = Hexachloroethane.

WP = White phosphorous.

1 Note, the fog oil amount, generator type and frequency information are what is used in equipment training (i.e. train soldiers how to use a fog oil generator).

2 Note, the fog oil amount, generator type and frequency information are what is used to train medical students in triage where there is limited visibility. The fog oil is generated within a tent, hence the small amount of fog oil used.

3 "Yes" or "No" refers to whether these constituents have ever been used at the installation.

4 "Yes" indicates that these constituents were used in training exercises in calendar year 2002.

Table 2. Munitions used in 2002 at Fort Rucker, Alabama.

DoD Identification Code	Description of Ammunition	Quantity Fired
A011	12 GUAGE	1,870
A059	5.56MM BALL	268,964
A062	5.56MM LINK BALL	57,904
A063	5.56MM TRACER	16,615
A064	5.56MM BALL LINKED TRACER	61,937
A066	5.56MM BALL	125,509
A068	5.56MM TRACER	20
A071	5.56MM BALL	58,544
A075	5.56MM BLANK	9,100
A080	5.56MM BLANK	88,598
A088	5.56MM TRACER	7,500
A111	7.62MM BLANK	19,893
A131	7.62MM BALL LINKED 4/1	60,552
A136	7.62MM BALL	2,000
A143	7.62MM BALL LINK 4/1	66,460
A146	CTG,7.62MM 4:1 LINKED	1,600
A164	7.62MM BALL M80 LINKED F/MG	5,772
A363	9MM BALL	132,368
A540	.50 CAL AP LNK 4/1	135,150
A555	.50 CAL BALL LNK 4/1	16,218
A940	CTG,25MM TPDS-T M910	1,331
A976	CTG,25MM TP-T M793 LNKD	573
AA11	7.62MM BALL	220
AA12	PAINT BALL	180
AA33	5.56MM BALL	62,240
AA49	9MM BALL	13,074
AX11	9MM TRACER	30
B118	30MM TP	206,769
B519	40MM GND PRAC	1,091
B579	40MM PRAC	56
B584	40MM TP LINK	406
B642	60MM HE	16
B643	60MM HE	644
B647	60MM ILLUM	103
C256	81MM HE	99
C868	81MM HE M821	348
C871	81MM ILLUM	40
D513	PROJ 155MM PRCT	160
D540	CHG PROP M3 GB	160
G878	HND GREN FUSE	800
G940	GRND, GRN SMK	518
G945	GRND, YLW SMK	212

DoD Identification Code	Description of Ammunition	Quantity Fired
G950	GRND, RED SMK	313
G955	GRND, VIO SMK	495
G982	Grenade, Smoke White, M83	8
HA13	2.75 IN ROCKET TP	45,366
HX05	83MM HE ROCKET	1
HX07	83MM TP ROCKET	10
K143	MINE AP M18A1	21
K765	CHEMICAL AGENT (CS)	215
L116	SIG KIT PER DIST RED	91
L119	SIG PER KIT DISTRESS	36
L275	SIG SMK ILLUM MK 13	191
L305	Sig Illum Grnd Grn Star M195	17
L306	SIM ILLUM GRND	119
L307	SIG ILLUM W/STAR	1
L594	SIM PROJ GB	1,090
L598	SIM EXP TRAP FLASH M117	121
L599	SIM BOOBY ILL M118	13
L600	BOOBY TRAP WHIST M119	282
L601	SIM HAND GRDE M116	809
M023	CHRG DEMO BL C4 M112	25
M030	CHG DEMO 1LB C4	20
M130	CAP BLAST ELEC	50
M131	CAP BLAST NON-ELEC	30
M327	BASE COUPLING FIRING DEVICE	15
M456	DET CORD	100
M546	40MM HEDP M433	6
M766	IGN TIMED	25
N286	M582 FUSE	80
N335	FUZE PD M557	80
N523	PRIMER M82	164
PE64	Tow Practice, EXT,BTM-71A	5
PM80	DRAGON GUIDED MISSLE	25
TOTAL ROUNDS:		1,475,468

Table 3. Munitions used in 2002 at Fort Irwin, California.

DODIC	Description of Ammunition	Quantity Fired
A010	CTG 10 GAGE BLANK/SUBCAL SALUTE M220	342
A011	CTG 12 GAGE #00 BUCKSHOT M19M/M162	700
A059	CTG 5.56 BALL F/M16A2	170,681
A062	CTG. 5.56MM BALL LINKED	73,200
A063	5.56MM TRACER F/M16A2	47,666
A064	5.56MM BALL AND TRACER LINKED	102,421
A066	CTG 5.56MM	43,684
A071	CTG., 5.56 BALL M193	11,760
A075	CTG 5.56MM BLANK, M200 LINKED	882,031
A080	CTG, 5.56MM BLANK M200	993,805
A106	CTG, CAL .22 BALL	20,000
A111	CTG 7.62MM BLANK M82 LNKD	1,951,280
A111	CTG 7.62MM BLANK M82 LNKD 800 BX	504,819
A131	CTG 7.62MM 4 & 1	515,682
A143	CTG. 7.62MM BALL LINKED	41,400
A146	CTG, 7.62MM, TRACER LINKED	200
A171	CTG,7.62MM,M852,MATCH	1,000
A358	CTG, 9MM TP-T	3,951
A363	CTG 9MM BALL NATO	70,637
A525	CARTRIDGE, .50 CAL AP	5
A552	CTG, CAL.50 BALL M2	60
A555	CTG CAL 50 BALL	9,600
A557	CARTRIDGE, .50 CAL BALL & TRACER	250,484
A598	CTG, CAL .50 BLANK	345,966
A940	CARTRIDGE, 25MM, TPDS-T	4,800
A940	CARTRIDGE, 25MM, TPDS-T	32,488
A976	CTG 25MM TP-T M793 LNK	10,154
A976	CTG 25MM TP-T M793 LNK	21,663
AA33	CTG, 5.56MM BALL COMMERCIAL PACK	445,444
AA49	CARTRIDGE, 9MM	48,565
B118	CTG 30MM TP	30,065
B568	CTG, .40MM HE M406	318
B584	CTG, 40MM TP-T M918	7,247
B610	LAUNCHER AND CARTRIDGE CS	83
B627	CTG 60MM ILLUM M83A3	129
B643	CARTRIDGE, 60MM, HE	962
B645	CTG 60MM TP	100
B646	CTG 60MM SMOKE WP	91
C045	KIT, REFURBISH F/CTG 81MM	86
C226	CARTRIDGE, 81MM ILLUMINATING	345
C256	CTG, 81MM HE M374	1,461
C276	CTG 81MM SMOKE WP M375A2 W/FZ	358
C379	CTG 120MM HE	363

DODIC	Description of Ammunition	Quantity Fired
C445	CTG 105MM M1 2 P/B	1,013
C445	CTG, 105MM HE, M1	1,535
C479	CTG 105MM SMOKE (HC) M84A1	197
C623	120 MM HE M933 W/FUZE PD	2,471
C624	CTG, 120MM SMOKE WP	635
C784	CTG 120MM TPW/T	4,259
C785	CTG 120MM TPCSDS-T M865	6,833
C876	CTG, 81MM	245
C995	LAUNCHER & CTG 84MM AT4	15
CX01	EXPENDED AT-4 LAUNCH TUBE ASSEMBLIES	22
D505	PROJECTILE, 155MM ILLUM M485A	387
D510	PROJ 155MM HEAT M712	21
D528	PROJECTILE, 155MM SMOKE WP M825	580
D528	PROJECTILE, 155MM SMOKE WP M825	1,266
D533	CHG PROPELLING 155MM M119	3,437
D540	CHG PROP 155MM GB M3A1	3,427
D541	CHARGE PROPELLING, 155M M4	14,722
D544	PROJECTILE 155MM HE M107 COMP B	308
D544	PROJECTILE 155MM HE M107 COMP B	1,950
D544	PROJECTILE, 155MM HE M107B2	5,846
D544	PROJECTILE, 155MM, HE, M107	8,660
D544	PROJECTILE, 155MM, HE, M107	811
D550	PROJECTILE, 155MM, SMOKE WP	16
D550	PROJECTILE,155 MM SMOKE WP	45
D579	PROJECTILE 155MM M549	509
D579	PROJECTILE, 155MM HERA M549A1	183
G841	CARTRIDGE, GRENADE 5.56MM	75
G878	FUZE HAND GREN M228	2,001
G881	GRENADE HAND M67	674
G900	GREN HAND INCD AN M14	12
G940	GRENADE HAND SMOKE GREEN M18	2,165
G945	GRENADE HAND SMOKE YELLOW M18	498
G950	GREN HAND SMOKE RED M18	1,073
G955	GRENADE HAND SMOKE VIOLET M18	1,643
G963	GRENADE,HAND	2,664
G982	GRENADE, HAND PRAC SMOKE TA	6,732
GM2B	STINGER TUBE ASSEMBLY LAUNCH	12
GM2C	DRAGON EXPENDED TUBE	5
H185	ROCKET POD PRACTICE (MLRS) M28A1	2
H463	ROCKET 2.75 W/WARHEAD, PRAC	34
H974	RKT, 2.75" WITH SMOKE PROJECTILE	168
H974	RKT, 2.75" WITH SMOKE PROJECTILE	24
H975	ROCKET PRACTICE 2.75IN	316
H975	ROCKET PRACTICE 2.75IN W/WARHEAD	572

DODIC	Description of Ammunition	Quantity Fired
HA17	ROCKET, 2.75" W/WARHEAD, PRACTICE	157
J143	ROCKET MOTOR 5 IN MK22 MOD 4	59
K008	FIRING DEVICE ELEC M57	82
K145	MINE, APERS M18A1 WO A	178
K180	MINE AT M15 1/BX	159
K181	MINE, AT HEAVY M21	7
K231	MINE AT M20 3/BOX	1,008
K250	MINE AT M19 HEAT 2/BX	6
K765	CHEMICAL AGENT CS (CAPSULE)	231
K866	SMOKE POT ABC-M5 GRD	1,008
L116	SIGNAL KIT PERS DISTRESS M185	148
L305	SIGNAL ILLUM GRN M195	40
L306	SIG ILLUM GRND RED STURNIN CLUS M158	837
L307	SIGNAL ILL GRD M159	128
L307	SIGNAL, W S CLUSTER, ILLUM	1,266
L311	SIGNAL ILLUM GRD, M126 SERIES	5
L312	SIGNAL GRND ILLUM SIG WHITE STURNIN	1
L312	SIGNAL ILLUM GRD, M127 SERIES	4,436
L314	SIGNAL ILL M125A1 36B	3,533
L366	SIMULATOR PROJ AIRBURST M74A1	25,421
L367	SIMULATOR, CARTRIDGE, ATWESS, M22	44,459
L495	FLARE SURF TRIP PARA	36
L594	SIMULATOR, PROJ GRD BURST	29,474
L598	SIMULATOR,EXPLOSIVE	66
L599	SIMULATOR, EXPLOSIVE	51
L600	SIMULATOR M119 150/B	62
L601	SIMULATOR HAND GRENADE	9,612
L602	SIMULATOR, ARTILLERY FLASH, 50MM M21	59,827
L603	SIM. FLASH ARTY. XM24E1	15,112
L709	SIM TURNINGET HIT	5,756
L715	SIMULATOR, MISSILE SAGGER, XM27	468
LA06	SIMULATOR, TANK MAIN GUN	30
LA07	SIMULATOR, M31A1	30
M023	CHG DEMO BLOCK M112 COMP	8,617
M028	DEMOLITION KIT BANG TORP M1A2	13
M030	CHARGE DEMO BLOCK TNT 1/4 LB	281
M032	CHARGE DEMOLITION BLOCK TNT 1 LB	230
M039	CHG DEMO CRATERING 40 LB	66
M044	CHARGE DEMOLITION MK26	629
M130	CAP BLAST M6 500/BX	584
M130	CAP BLAST M6 500/BX	79
M131	CAP BLASTING, NON-ELECTRIC	612
M174	CTG IMPULSE .50 CAL	134
M327	COUPLING BASE,FIRING DEVISE W/PRIME	335

DODIC	Description of Ammunition	Quantity Fired
M420	CHARGE, DEMOLITION SHAPED	22
M421	CHARGE DEMO M3 1 P/B	72
M456	CORD DET 4000FT P/BOX	83,283
M591	DYNAMITE, MILITURNINY M1 38.5LB BX	420
M670	FUZE BLASTING TIME M700	5,500
M757	CHG ASSY DEMO M183	6
M766	IGNITER M60 300 P/B	403
M913	CHARGE DEMOLITION LINEAR M58A4	35
ML03	FIRING DEVICE, DEMO M142	186
ML04	CUTTER HIGH EXPLOSIVE	48
ML05	CUTTER HE MK24	27
ML15	CHARGE DEMO	205
ML15	CHARGE DEMO FLEX LINEAR SHAPED	282
ML45	M9 HOLDERS BLASTING, VARIOUS DWGS	3,938
ML47	CAP, BLASTING NON-ELECTRIC	1,970
MM50	SHAPED CHARGE, DEMO	59
MN02	CAP, BLASTING NON-ELECTRIC	201
MN03	CAP, BLASTING NON-ELECTRIC	322
MN06	CAP, BLASTING NON-ELECTRIC, DELAY	1,113
MN07	CAP, BLAST NON-ELECT DELAY	2,149
MN32	DYNAMITE, 60% AMMONIUM NITRATE	6
MN60	ELECTRIC MATCH ASSY	713
MN68	BOOSTER, DEMOLITION CHARGE, M151	50
MN69	BOOSTER, DEMOLITION CHARGE, M152	55
MU34	REFIRE KIT CABLE & CUTTER ASSEMBLY	2
N278	FUZE MTSQ M564 W/BOOSTER WRBN BX	16
N285	FUZE MTSQ M577 W/O BOOSTER	2,139
N286	FUZE MTSQ M582, WRBND BX	37
N286	FUZE MTSQ M582, WRBND BX	2,053
N340	FUZE PD M739 WRBND BX	17,078
N340	FUZE, POINT DETONATING M739	1,914
N464	FUZE, PROXIMITY M732	827
N523	PRIMER PERCUSSN M82	23,048
PA79	GM SURFACE ATTACK HELLFIRE	1
PB99	GM. PRAC BTM-71A-3 <TOW>	6
PE64	GUIDED MISSLE, SURFACE	1
PL23	GM, SURFACE ATTACK DRAGON	5
PL94	GM INTERCEPT AERIAL STINGER ROUND	1
PL95	STINGER MISSILE	6
PL96	GM INTERCEPT AERIAL (STINGER RND)	5
YW33	SAGGER SAM, SMOKEY SAM	252
TOTAL ROUNDS:		7,087,888

Table 4. Munitions used in 2002 at Fort Benning, Georgia.

DoD Identification Code	Description of Ammunition	Quantity Fired
A001	CTG, 12 GAGE SKEET #9 SHOT	10,560
A011	CTG, 12 GAGE #00 BUCKSHOT M19/M162	6,136
A014	CTG, 12 GAGE #7 1/2 SHOT	1,278
A052	CTG, .410 SHOOTGUN SKEET #9 SHOT	759
A058	CTG, 5.56MM BALL M855 SNGL RD	840
A059	CTG, 5.56MM BALL M855 10/CLIP	4,888,754
A062	CTG, 5.56MM BALL M855 LNKD	393,131
A063	CTG, 5.56MM TR M856 SNGL RD	184,817
A064	CTG, 5.56MM 4 BALL M855/1 TR M856 LNKD	2,104,091
A065	CTG,5.56MM SR M862 SNGL RD (Short Range Training ROUND)	3,100
A066	CTG, 5.56MM BALL M193 SNGL RND	135,773
A070	CTG, 5.56MM HPT M197 SNGL RD	14,420
A071	CTG, 5.56MM BALL M193 10/CLIP	2,550,187
A075	CTG, 5.56MM BLANK M200 LNKD	17,555
A079	CTG, 5.56MM BLANK M755 F/64MM KE PROJ (GREN LNCHR)	20,160
A080	CTG, 5.56MM BLANK M200 SNGL RD	82,960
A085	CTG, CAL .22 SHORT BLANK	1,633
A091	CTG, CAL .22 BALL LR MATCH (RIFLE)	4,750
A095	CTG, CAL .22 SHORT BALL MATCH (PISTOL)	363
A111	CTG, 7.62MM, BLANK, M82, LNK	1,600
A127	CTG, 7.62MM 4 BALL M59/M80/1 TR M62 LNKD	133,014
A131	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	1,373,361
A136	CTG, 7.62MM BALL M118 MATCH SNGL RD	116,080
A143	CTG, 7.62MM BALL M80 LNKD	136,520
A146	CTG, 7.62MM TR M62 LNKD	900
A151	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	380,780
A166	CTG, 7.62MM BALL M80 SNGL RD	150
A170	CTG, 7.62MM HLLW PNT RT-TL MATCH SNGL RD (SRTR)	2,113
A171	CTG, 7.62MM MATCH M852 SNGL RD	23,906
A172	CTG, 7.62MM PRAC XM869 SNGL RD	350
A234	CTG, CAL .30 TR M1/M25 8/CLIP	75
A255	CTG, 7.62 4-BALL M80, 1-DIM TR M1276	42
A358	CTG, 9MM TP-T M939 F/AT-4 TRNR	95,008
A360	CTG, 9MM BALL M1 PARABELLUM	4,666
A363	CTG, 9MM BALL M882	206,194
A365	CTG, 14.5MM TRAINER M181 3 SEC DELAY	434
A483	CTG, CAL .45 BALL M1911 MATCH	200
A531	CTG, CAL .50 API M8 AC SNGL RD	3,043
A540	CTG, CAL .50 4 API M8/1 TR M1/M17 LNKD	745
A552	CTG, CAL .50 BALL M2 CTN PACK	552
A555	CTG, CAL .50 BALL M2/M33 LNKD	36,546
A557	CTG, CAL .50 4 BALL M33/M2/1 TR M17/M10 LNKD	88,216

DoD Identification Code	Description of Ammunition	Quantity Fired
A576	CTG, CAL .50 4 API M8/1 API-T M20 LNKD	885
A606	CTG, CAL .50 API MK211 SNGL RD	2,200
A701	CTG, 20MM HEI M56A3 SERIES LNKD	3,200
A940	CTG, 25MM TPDS-T M910 & M910, IN, PA 125, CNTR	54,030
A953	CTG, 20MM HEI M56 SERIES LNKD	5
A974	CTG, 25MM APDS-T M791 LNKD	60
A976	CTG, 25MM TP-T M793 LNKD	22,905
AA01	CTG, 5.65 AP M995 LNKD	20,668
AA11	7.62mm LR (7.62) Ball	65,811
AA12	9mm, Red Non-lethal Marking cartridges (Simunitions)	32,800
AA21	9mm, FX MKG Blue Non-lethal Marking cartridges (Simunitions)	30,542
AA31	CTG, 12 GAGE FIN STABILIZED NON-LETHAL	4,500
AA33	Cartridge, Small Arms, 5.56 Ball	7,408,213
AA48	CTG, 5.56mm, Ball (Lead Free)	28,800
AA49	9mm Ball	38,464
AAAD	Rubber Fin Stabilized Round (23FS) (12 Gauge)	12,000
B511	CTG, 40MM TP M813 4/CLIP	110
B517	CTG, 40MM HEI-PD M811 4/CLIP	912
B518	CTG, 40MM HE-PFPX M822 4/CLIP	700
B519	CTG, 40MM TP M781	207,983
B534	CTG, 40MM MP M576	1,100
B535	CTG, 40MM ILLUM WHT STAR PARA M583	47
B542	CTG, 40MM HEDP M430 LNKD	612
B545	CTG, 40MM BLANK SALUTING	394
B546	CTG, 40MM HEDP M433 (PA120 MTL CNTR)	3,227
B549	CTG, 40MM HEI-P M162	1,400
B558	CTG, 40MM HEI-T-NSD 4/CLIP	10
B568	CTG, 40MM HE M406	564
B569	CTG, 40MM HE M397	15
B584	CTG, 40MM TP M918 LNKD	32,470
B585	CTG, 57MM CANISTER T25E5	20
B630	CTG, 60MM SMK WP M302 SERIES	40
B642	CTG, 60MM HE XM720	360
B643	CTG, 60MM HE M888	3,921
B645	CTG, 60MM TP SHORT M840 (SRTR)	698
C004	SABOT, 81MM, PRAC.	355
C009	CTG, IGN M285 F/81MM MORTAR	144
C045	REPAIR KIT AMMO 81MM 7/B	3,033
C074	CTG, 81MM, M374A3	116
C205	CTG, 3 IN 50 CAL VT MK31	64
C226	CTG, 81MM ILLUM M301 SERIES	1,877
C256	CTG, 81MM HE M374 SERIES W/PD FUZE	2,834
C276	CTG, 81MM SMK WP M375/M375A2/M375A3 W/PD FUZE	100

DoD Identification Code	Description of Ammunition	Quantity Fired
C356	CTG, 3 IN 50 CAL VT MK31 FLASHLESS	1,068
C379	CTG, 120MM HE M934 W/FUZE MO M734	313
C382	CTG, 84MM HE, FFV 441B FOR RAAWS	111
C383	CTG, 84MM, HE, FFV 551 FOR RAAWS	25
C384	CTG, 84MM, ILLUM, FFV545B FOR RAAWS	48
C385	CTG, 84MM, SMOKE, FFV469B FOR RAAWS	38
C386	CTG, 84MM, TP, FFV552 FOA RAAWS	40
C387	CTG, 84MM HEDP FFV502	6
C623	CTG, 120MM HE XM933	316
C624	CTG, 120MM SMK	256
C784	CTG, 120MM TP-T M831 WDN CNTR) & M831 (METAL CNTR)	315
C785	CTG, 120MM TPCSDS-T M865 (METAL CNTR) & (WDN CNTR)	619
C786	CTG, 120MM, APFSDS-T, M829 & M829 (PA-116 CNTR)	41
C868	CTG 81MM HE M821 W/MO FZ M734 2/B, M984 3/CNT, M821 MULTI-OP	1,788
C870	CTG, 81MM SMK RP M819 W/MTSQ FUZE M772	20
C871	CTG, 81MM ILLUM M853A1 W/FUZE MTSQ M772, W/ FUZE	553
C876	CTG, 81MM, M880	140
C878	CTG, 81MM HE, M984 W/FUZE MULTI-OPTION	308
C995	CTG & LAUNCHER, 84MM M136 AT-4	134
CA03	CTG, 120MM WP M929 W/MO FZ (SEE C624)	36
CA05	CTG, 120MM HE-OR-T XMM908/M908	110
CA09	Cartridge, 120MM:Full Range Practice, M931 W/ FUZE, PD, M931	1,606
D505	PROJ, 155MM ILLUM M485 SERIES	159
D544	PROJ, 155MM HE M107	1,311
D545	PROJ, 155MM ILLUM M118	6
D550	PROJ, 155MM SMK WP M105/M110 SERIES	28
DWBS	Flash Bang Distraction Device, XM-84	21
E745	BOMB, CLUSTER INC TH-3 750 LB M36E3	32
G042	INITIATOR, BOMB FUZE	360
G382	TARGET DETECTING DEVICE, FUZE	6
G878	FUZE, HAND GREN PRAC M228	13,133
G881	GRENADE, HAND FRAG M67	21,730
G887	GRENADE, HAND FRAG M59	163
G888	GRENADE, HAND FRAG M33	220
G890	GRENADE, HAND FRAG MK2/M26 SERIES	1
G900	GRENADE, HAND INCD TH-3 AN-M14	290
G930	GRENADE, HAND SMK HC AN-M8	12
G940	GRENADE, HAND SMK GRN M18	5
G945	GRENADE, HAND SMK YLW M18	20
G950	GRENADE, HAND SMK RED M18	70
G955	GRENADE, HAND SMK VIO M18	10
G982	GRENADE, HAND, PRACTICE	40

DoD Identification Code	Description of Ammunition	Quantity Fired
G995	GRENADE, RIFLE SMK GRN M22	1
H975	ROCKET, 2.75" PRAC M274 MK66 MOD 3	52
HA16	RCKT, 84MM HEATFFV551 W/IM WHD	10
K001	ACTIVATOR, M1 F/AT MINE M15	42
K143	MINE, APERS M18A1 W/M57 FIRING DEVICE	357
K145	MINE, APERS M18A1 W/O FIRING DEVICE	199
K180	MINE, AT HEAVY M15	11
K181	MINE, AT HEAVY M21	17
K250	MINE, AT HEAVY M19 NON-METALLIC	15
K765	RIOT CONTROL AGENT, CS	4
K867	SMOKE POT, FLOATING HC M4A2	10
L212	MARKER, LOCATION YLW MK22 MOD 0	12
L306	SIGNAL, ILLUM GRND RED STAR CLUSTER M158	28
L311	SIGNAL, ILLUM GRND RED STAR PARA M126	48
L312	SIGNAL, ILLUM GRND WHT STAR PARA M127A1	1,389
L314	SIGNAL, ILLUM GRND GRN STAR CLUSTER M125A1	5
L495	FLARE, SURF TRIP PARA YLW M49 SERIES	32
L497	FLARE, SURFACE, PRACTICE	75
L601	SIMULATOR, HAND GREN M116A1	20
L602	SIM FLASH ARTY M21 9/CT IN BG 162/B	10
M008	CTG, IMPULSE M270	549
M009	CTG, IMPULSE	84
M011	CTG, IMPULSE MK17 MOD 1	108
M012	CTG, IMPULSE MK19 MOD 0	56
M015	CTG, IMPULSE MK24 MOD 0	12
M020	CHG, DEMO SHAPED MK45	14
M022	CHG, DEMO SHAPED PETN	29
M023	CHG, DEMO BLOCK M112 1 1/4 LB COMP C-4	1,941
M024	CHG, DEMO BLOCK M118 2 LB PETN	98
M028	DEMO KIT, BANGALORE TORP M1A2	30
M029	CHG, DEMO SHAPED FLEX LINEAR	20
M030	CHG, DEMO BLOCK TNT 1/4 LB	2,267
M031	CHG, DEMO BLOCK TNT 1/2 LB	22
M032	CHG, DEMO BLOCK TNT 1 LB	274
M034	CHG, DEMO BLOCK TNT 8 LB	5
M039	CHG, DEMO BLOCK 40 LB CRATERING	48
M073	CTG, IMPULSE CCU 11/B BDU-38B	15,000
M097	CAP, BLASTING, NON-ELECTRIC, INERT	20
M098	CAP, BLASTING, ELECTRIC, INERT	20
M115	CAP, BLASTING ELEC NO 6	248
M130	CAP, BLASTING ELEC M6 & M6 ELEC, IMPROVED PACKAGING	1,384
M131	CAP, BLASTING NON-ELEC M7	211
M153	CAP, BLASTING ELEC SPEC STRENGTH E108	12

DoD Identification Code	Description of Ammunition	Quantity Fired
M193	CTG, ACFT FIRE EXTINGUISHER	1,100
M223	CTG, IMPULSE M37	8
M420	CHG, DEMO SHAPED M2 SERIES 15 LB	71
M443	DEMO KIT, PROJ CHG M173	400
M456	CORD, DET, PETN, TYPE 1 CL E (NEW=1000 FT)	38,616
M458	CORD, DET, 1000 FT SPOOL 1000 FT/B	218
M591	DYNAMITE, MILITARY M1	18
M670	FUZE, BLASTING TIME M700	100
M701	INITIATOR, CTG ACTUATED MK11 MOD 0	100
M766	IGNITER, M2/M60 F/TIME BLASTING FUSE	60
M783	CTG, IMPULSE	444
M816	INITIATOR, CTG ACTUATED	6
M855	CAP, BLASTING ELEC	9,100
ML23	CAP, BLASTING ELEC EXPLODING BRIDGE WIRE	55
ML45	HOLDER, BLASTING CAP	15
ML47	CAP, BLASTING	1,241
MM30	Booster PETN 20 gram	298
MM31	CHG, DEMO, LINEAR SHAPED 6 FT	20
MN02	CAP, BLASTING NON-ELEC 500FT SHK TUBE XM12/M12	268
MN03	CAP, BLASTING NON-ELEC 1000FT SHK TUBE XM12/M12	125
MN06	CAP, BLASTING NON-ELECT DELAY XM14/M14	1,103
MN08	IGNITER, TIME BLASTING FUSE XM147/M147	1,589
MN11	FIRING DEVICE, DEMO TIME DELAY XM147/M147	7
N335	FUZE, PD M557	32
NONE	Non-Military Munitions	763,678
PE64	GUIDED MISSILE, PRAC BTM-71A-3A EXT RANGE (TOW)	25
PL23	GUIDED MISSILE W/LNCHR SURF ATTACK M222 (DRAGON) (04)	4
X104	Hatton Shotgun Round, 12 gauge	1,073
X455	DETA Prime Booster	25
X554	Nonel 1000	4
X577	Shock Tube Igniter	13
X585	Nonel 100	30
	TOTAL ROUNDS:	21,904,094

Table 5. Munitions used in 2002 at Fort Gordon, Georgia.

DOD Identification Code	Description of Ammunition	Quantity Fired
A011	12GA SHOTGUN 00 BUCKSHOT	1,580
A014		200
A017		740
A059	5.56MM BALL F/M16A2	55,726
A062	5.56MM BALL LKD F/SAW	15,180
A063	5.56MM TR F/M16A2	200
A064	5.56MM BALL TR 4/1 F/SAW	12,955
A071	5.56MM BALL (M16) 10/CLIP	108,651
A075	5.56MM BLANK LKD F/SAW	16,863
A080	5.56MM BLK F M16A1/A2	152,482
A111	7.62MM BLNK LNKD (MILES)	4,945
A131		7,600
A136		1,227
A143		1,918
A363	9MM BALL PISTOL	74,609
AA33	5.56MM BALL COMMER PACK, CTG	94,053
AA49	CARTRIDGE, 9MM BALL M882	5,550
B519	40MM PRAC M781	1,998
G924		50
G940	GREN SMK GRN (MILES)	125
G945	GREN HAND SMK YEL	141
G950	GREN HAND SMK RED	13
G955	GREN HAND SMK VIOL	75
G963	GREN HAND RIOT CS	11
G982	HAND GRENADE SMOKE TNG M83	32
K139	DDI, MINE APERS M68 PRAC	6
K765	RIOT CNTRL AGENT CS CAPSULE	363
K866		4
L307	SIG ILLUM WS CLUSTER M159	4
L311	SIG ILLUM RS PARA M126A1	15
L312	SIG ILLUM WS PARA M127A1	22
L594	LIM PROJ GRND BRST M115A2	16
L601	SIM HAND GREN M116 SERIES	2
TOTAL ROUNDS:		557,356

Table 6. Target species on Fort Gordon.

Scientific name	Common name	State status	Federal status	Global rank	State rank
BIRDS					
Aimophila aestivalis	Bachman's sparrow	R	SC	G3	S3
Falco sparverius paulus	Southeastern American kestrel	tracked	SC	G5T3T4	S3
Haliaeetus leucocephalus*	bald eagle	E	T	G4	S2
Lanius ludovicianus migrans**	loggerhead shrike (migrant)	tracked	SC	G5T3Q	S?
Mycteria americana*	wood stork	E	E	G4	S2
Picoides borealis	red-cockaded woodpecker	E	E	G3	S2
FISHES					
Acantharchus pomotis	mud sunfish	tracked	-	G5	S3
Elassoma okatie	bluebarred pygmy sunfish	1st find in GA	-	G2G3	-
Etheostoma fricksium	Savannah darter	tracked	-	G3	S2
Etheostoma serriferum	sawcheek darter	tracked	-	G5	S3
Pteronotropis hypselopterus	sailfin shiner	tracked	-	G5	S3
HERPS					
Gopherus polyphemus	gopher tortoise	T	SC	G3	S3
Heterodon simus	Southern hognose snake	tracked	SC	G4	S3
Pituophis melanoleucus mugitus	Florida pine snake	tracked	SC	G5T3?	S3
MAMMALS					
Corynorhinus rafinesquii	Rafinesque's big-eared bat	R	SC	G3G4	S3?
Myotis austroriparius	Southeastern bat	tracked	SC	G3G4	S3
PLANTS					
Agrimonia incisa	cut-leaf harvest lice	tracked	-	G3	S3
Carphephorus bellidifolius	sandy-woods chaffhead	tracked	-	G4	S1?
Ceratiola ericoides	rosemary	T	-	G4	S2
Chamaecyparis thyoides	Atlantic white-cedar	R	-	G4	S2
Chrysoma paucifloculosa	woody goldenrod	tracked	-	G4G5	S3
Cypripedium acaule	pink ladyslipper	U	-	G5	S4
Liatris secunda	sandhills gay-feather	tracked	-	G4G5	S1?
Macbridea caroliniana	Carolina bogmint	tracked	SC	G2G3	S1?
Nestronia umbellula	Indian-olive	T	SC	G4	S2
Rhododendron flammeum	Oconee azalea	tracked	-	G3	S3
Sarracenia rubra var. rubra	sweet pitcherplant	E	-	G3	S2
Silene caroliniana	Carolina pink	tracked	-	G5	S2?
Stewartia malacodendron	silky camelia	R	-	G4	S2
Stylisma pickeringii var. pickeringii	Pickering's morning-glory	T	SC	G4?T2T3	S2
Warea cuneifolia	sandhill-cress	tracked	-	G4	S3
Source: Directorate of Public Works, U.S. Army Signal Center & Fort Gordon, Fort Gordon, Georgia					

Table 7. Munitions used in 2002 at Fort Stewart, Georgia.

DOD Identification Code	Description of Ammunition	Quantity Fired
A010	CTG, 10 GAGE BLANK F/37MM GUN	4729
A011	CTG, 12 GAGE #00 BUCK	8383
A059	CTG, 5.56MM BALL M855 10/CLIP	2259948
A060	CTG, 5.56MM DUMMY, M199 CTN PK	7000
A062	CTG, 5.56MM BALL M855 LNKD	125004
A063	CTG, 5.56MM TR M856 SNGL RD	76389
A064	CTG, 5.56MM 4 BALL M855/1 TR M856 LNKD	605107
A065	CTG, 5.56MM BALL PRAC M862 SNGL RD	35161
A066	CTG, 5.56MM BALL M193 CTN PACK	910497
A068	CTG, 5.56MM TR M196 CTN PACK	40176
A071	CTG, 5.56MM BALL M193 10/CLIP	1100
A072	CTG, 5.56MM TR M196 10/CLIP	54462
A075	CTG, 5.56MM BLANK M200 LNKD	479899
A080	CTG, 5.56MM BLANK M200 SNGL RD	37272
A090	CTG, CAL .22 TR PRAC M861	400
A107	CTG, CAL .22 LR HIGH VELOCITY	7689
A111	CTG, 7.62MM, BLANK, M82, LNK	20376
A112	CTG, 7.62MM BLANK M82 CTN PACK	9300
A127	CTG, 7.62MM 4 BALL M59/M80/1 TR M62 LNKD	114020
A130	CTG, 7.62MM BALL M59/M80 5/CLIP	11223
A131	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	1032002
A136	CTG, 7.62MM BALL M118 MATCH CTN PACK	4190
A143	CTG, 7.62MM BALL M80 LNKD	33362
A146	CTG, 7.62MM TR M62 LNKD	16063
A165	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD F/M-GUN	5905
A254	SUBCAL GUSTAFF	200
A353	CTG 9MM TRACER SUBCAL FOR AT4	23
A358	CTG, 9MM TP-T M939 F/AT-4 TRNR	12479
A360	CTG, 9MM BALL M1 PARABELLUM	136896
A363	CTG, 9MM BALL M882	240095
A520	CTG, CAL .50 4 BALL M33/1 TR M17 LNKD	61755
A533	CTG, CAL .50 API M8 AC LNKD	3
A540	CTG, CAL .50 4 API M8/1 TR M1/M17 LNKD	9808
A546	CTG, CAL .50 BALL M2 LNKD	1200
A555	CTG, CAL .50 BALL M2/M33 LNKD	16907
A557	CTG, CAL .50 4 BALL M33/M2/1 TR M17/M10 LNKD	391965
A585	CTG, CAL .50 API-T M20 LNKD	200
A593	CTG CAL.50 LKD 4 AP& 1TRACER	1309
A598	CTG, CAL .50 BLANK M1E1 LNKD	960
A606	CTG, CAL .50 API MK211 SNGL RD	500
A608	CTG, CAL .50 4 API MK211/1 TR M17 LNKD	4000

DOD Identification Code	Description of Ammunition	Quantity Fired
A662	CTG, 20MM HEI M56 SERIES LNKD (04)	700
A857	CTG, 20MM 7 TP M55A2/1 TP-T M220 LNKD	300
A896	CTG, 20MM 4 TP M55A2/1 TP-T M220 LNKD	1018
A940	CTG, 25MM TPDS-T M910 (08)	43894
A974	CTG, 25MM APDS-T M791 LNKD	950
A975	CTG, 25MM HEI-T M792 LNKD (04)	2194
A976	CTG, 25MM TP-T M793 LNKD	38164
AA11	7.62MM NATO M118	200
AX11	9MM SUBCAL FOR SMAW	3800
B103	CTG, 30MM 5 API PGU-14A/B/1 HEI PGU-13/B LNKD(04)	381
B120	CTG, 30MM TP M788 LNKD RHF	14261
B134	DUMMY CTG, 30MM	867
B470	CTG, 40MM HE M384 SERIES LNKD (12)	2657
B480	CTG, 40MM TP M385 SERIES LNKD F/HELI LAUNCHER	171
B509	CTG, 40MM YLW SMK M716	13
B519	CTG, 40MM TP M781	46381
B542	CTG, 40MM HEDP M430 LNKD (04)	8425
B546	CTG, 40MM HEDP M433 (PA120 MTL CNTR)	2633
B576	CTG, 40MM TP M385 LNKD	12
B584	CTG, 40MM TP M918 LNKD	49947
B592	CTG, 40MM TP M918 SNGL RD	50
B642	CTG, 60MM HE XM720 (08)	1188
C045	REPAIR KIT AMMO 81MM 7/B	34
C226	CTG, 81MM ILLUM M301 SERIES (08)	439
C228	CTG 81MM TP	584
C256	CTG, 81MM HE M374 SERIES W/PD FUZE (08)	1250
C263	CTG DUMMY 90MM M12	232
C276	CTG, 81MM SMK WP M375 W/PD FUZE (12)	814
C379	CTG120MM W/MULTIPLEOPTION FUZE	197
C382	CTG, 84MM HE, FFV 441B FOR RAAWS	24
C384	CTG, 84MM, ILLUM, FFV545B FOR RAAWS (08)	31
C385	CTG, 84MM, SMOKE, FFV469B FOR RAAWS (12)	8
C386	CTG, 84MM, TP, FFV552 FOA RAAWS (08)	3
C387	84MM HEDP	2
C445	CTG, 105MM HE M1 W/O FUZE (12)	803
C449	CTG, 105MM ILLUM M314 SERIES (08)	87
C520	CTG, 105MM TPDS-T M724A1 (04)	20
C623	CTG, 120MM HE XM933	858
C708	CTG, 4.2 IN SMK WP M2/M328 SERIES W/PD FUZE (12)	20
C784	CTG, 120MM TP-T	5753
C785	CTG, 120MM TPCSDS-T M865 (METAL CNTR) (08)	5154
C788	CTG, 120MM HE M57 W/FUZE PD M935 (08)	1207

DOD Identification Code	Description of Ammunition	Quantity Fired
C789	CTG, 120MM SMOKE, WP, M68 (04)	303
C790	CTG, 120MM ILLUM, M91 (02)	12
C876	CTG, 81MM, M880	775
C995	CTG & LAUNCHER, 84MM M136 AT-4 (12)	1387
D445	CANISTER, SMK HC M1 F/155MM M116 SERIES	70
D502	PROJ, 155MM HE ADAM M731 (12)	1
D505	PROJ, 155MM ILLUM M485 SERIES	658
D513	PROJ, 155MM PRAC M804	161
D528	PROJ, 155MM SMK WP M825 (02)	166
D544	PROJ, 155MM HE M107 (18)	5890
D550	PROJ, 155MM SMK WP M105/M110 SERIES (12)	88
D563	PROJ, 155MM HE APER M483 SERIES (18)	733
D579	PROJ, 155MM HE RAP M549 SERIES (COMP B) (18)	8
E485	BOMB, GP 500 LB MK82 MOD 1 TRITONAL	25
F244	BOMB GP 500LB MK82 INERT	24
G811	BODY, PRACTICE HAND GRENADE f/M69	500
G826	GRENADE, LAUNCHER SMK IR SCREENING M76 (02)	8
G878	FUZE, HAND GREN PRAC M228	7694
G881	GRENADE, HAND FRAG M67 (04)	5790
G911	GRENADE, HAND OFF MK3A2	10
G945	GRENADE, HAND SMK YLW M18	12
G963	GRENADE, HAND RIOT CS M7 SERIES	1
G982	GRENADE, HAND, PRACTICE	32
GLD	GROUND LASER DESIGNATOR	252
H180	ROCKET, 2.75" FLARE W/M275 WHD AND MK 40 MTR	597
H185	ROCKET, POD, REDUCED RANGE PRAC. M28A1 MLRS	140
H463	ROCKET, 2.75 IN MPSM PRAC W/WHD M267 (HYDRA) (04)	563
H464	ROCKET, 2.75 IN MPSM W/WHD M261 (HYDRA-70) (09)	120
H519	ROCKET, 2.75 IN SMK WP W/WHD M156 (04)	20
H557	ROCKET, 66MM HEAT M72A2	6
H974	ROCKET, 2.75" WHD M267, FZ M439, MTR MK66 MOD3 (04)	380
H975	ROCKET, 2.75" PRAC M274 MK66 MOD 3	2543
HA16	84MM HEAT	20
J106	ROCKET MOTOR, 2.75 IN MK125 SERIES	8
J143	ROCKET MOTOR, 5 IN MK22 MOD 4 (FOR MICLIC)	12
K042	MINE, CANISTER PRAC XM88 (VOLCANO)	6
K143	MINE, APERS M18A1 W/M57 FIRING DEVICE	188
K180	MINE, AT HEAVY M15	3
K181	MINE, AT HEAVY M21	197
K250	MINE, AT HEAVY M19 NON-METALLIC	3

DOD Identification Code	Description of Ammunition	Quantity Fired
K765	RIOT CONTROL AGENT, CS	781
K768	RIOT CONTROL AGENT, CS-1	429
L312	SIGNAL, ILLUM GRND WHT STAR PARA M127A1	26
L602	SIM FLASH ARTY M21 9/CT IN BG 162/B	1
M023	CHG, DEMO BLOCK M112 1 1/4 LB COMP C-4	3100
M024	CHG, DEMO BLOCK M118 2 LB PETN	100
M028	DEMO KIT, BANGALORE TORP M1A2	50
M030	CHG, DEMO BLOCK TNT 1/4 LB	100
M039	CHG, DEMO BLOCK 40 LB CRATERING	289
M131	CAP, BLASTING NON-ELEC M7	30
M420	CHG, DEMO SHAPED M2 SERIES 15 LB	48
M421	CHG, DEMO SHAPED M3 SERIES 40 LB	593
M456	CORD, DET, PETN, TYPE 1 CL E (NEW=1000 FT)	158
M670	FUZE, BLASTING TIME M700	45
M766	IGNITER, M2/M60 F/TIME BLASTING FUSE	40
M918	CTG 40MM TP UNLINKED F/CEV	12519
M996	CHG, DEMO RIGID LINEAR MK87 MOD 0	6
MD15	CORD, DET FCDC	2887
ML03	FIRING DEVICE, DEMO MULTI-PURPOSE M142	111
ML15	CHG, DEMO FLEX LINEAR SHAPED 225 GR/FT	30
PA79	GUIDED MISSILE, SURF ATTCK AGM-114A REDUCD SMK (HELLFIRE)	145
PB94	GUIDED MISSILE, SURF ATTACK BGM-71A2 STD RANGE (TOW)	22
PB96	GUIDED MISSILE, PRAC BTM-71A2 STD RANGE (TOW)	15
PD68	GUIDED MISSILE, SURF ATTACK AGM-114C MIN SMK (HELLFIRE)	106
PL23	GUIDED MISSILE W/LNCHR SURF ATTACK M222 (DRAGON) (04)	8
PL34	GUIDED MISSILE SURFACE ATTACK AAWS-M (JAVELIN)	4
PL90	GUIDED MISSILE ROUND, INTER-AERIAL FIM 92A (STINGER-BASIC)	76
PL93	GUIDED MISSILE SUBSYS, INTER-AERIAL FIM 92A (STINGER-BASIC)	4
PV04	GUIDED MISSILE, PRAC BTM-71A-2B (BASIC)	57
X104	12GAUGEHAT	40
X281	7.62MM 168 GR MATCH	14
X338	5.56FLANGE	3400
X471	MM51 ECT 600 GR	43
X472	MK144 ECT 1200 GR	24
X577	INITIATOR SHOCK TUBE	15
X589	N-EL DIR SHOOT 6.4 SEC	25
TOTAL ROUNDS:		7,068,430

Table 8. Munitions used in 2002 at Fort Campbell, Kentucky.

DOD Identification Code	Description of Ammunition	Quantity Fired
0171	7.62BALL	167,347
A011	12GA,00BCK	143
A017	12GA, #9	3,809
A059	5.56M/M855	1,277,173
A060	5.56MBLK	300
A062	5.56MLINKD	1,428,847
A063	5.56MTM856	169,019
A064	5.56M4/1	368,043
A065	5.56 BALL	2,377,501
A066	5.56MBAL	781,939
A068	5.56MTM196	2,250
A071	5.56M/M193	9,112
A072	5.56M,TR	5,399
A075	5.56MBLSAW	935,318
A076	5.56 DUMMY	3,500
A080	5.56MBM200	462,388
A083	7.62X54M	2,550
A107	7.62M39BAL	310,570
A111	7.62MBLM82	310,325
A112	7.62MBM82	126,086
A127	7.62M,4/1	10,280
A130	7.62MBALL	746,056
A131	7.62ML4/1	668,621
A135	7.62MBLK	1,400
A136	7.62MBM118	49,742
A143	7.62MLKDB	157,523
A151	7.62MMLKD	57,669
A165	7.62MM4/1	295,825
A171	7.62 BALL	280,222
A353	AT4SUBCAL	3,832
A358	9MM AT4	19,497
A360	9MMB	425,767
A363	9MMBM882	456,219
A520	.50 4&1B/T	275
A525	CAL .50	45,125
A531	.50APIM8AC	2,456
A540	.50 4&1A/T	35,333
A546	.50 BALL	38,249
A552	.50BALL,CT	172,848
A555	.50 BALL	2,083
A557	.50 4&1B/T	50,420

DOD Identification Code	Description of Ammunition	Quantity Fired
A576	.50 API	16,098
A596	.504&1A/T	1,828
A602	.50CLBL4/1	73,715
A965	25.4MDEC	700
AA33	5.56COMPAC	8,100
B103	30MMAPIHEI	800
B118	30MTP788	76,280
B120	30MMTP	44,240
B129	30HEDPSTR	4,920
B470	40MM	1,990
B480	40MMTPHEL	418
B508	40MMGRDGRE	100
B519	40MMTPM781	103,299
B535	40MM ILLUM	295
B542	40MMLKD430	3,811
B546	40MMHEDP	28,096
B571	40MMHE RW	865
B576	40MMTPLKD	4,762
B584	40MMPRLKD	8,549
B627	60MMULUM	65
B629	60MMTP	61
B630	60MSMKPW	214
B642	60MMHE	3,122
B643	60MHEM888	1,453
B645	60MTPRAC	962
B646	60MSMKPW	2
B647	60MILLUM	152
B653	60MPRASRM	1,539
C045	81MM PRAC	2,091
C226	81MMILLUM	561
C228	81MMHE	1,657
C256	81MMHE	1,417
C276	81MMSMKWP	154
C445	105MMHER	11,947
C449	105MMILHOW	1,092
C452	105MSMK	294
C463	105MHEM548	1,469
C479	105MSMKHCE	168
C511	105MM/M490	12
C868	81MHEM821	381
C876	M203	25
C995	84MMAT4	18

DOD Identification Code	Description of Ammunition	Quantity Fired
D505	155MM ILL	336
D528	155MM SMK	21
D544	155MM HE	878
D563	155MM HE	371
D579	155MM HE	45
D680	81INHE106	55
G881	FRAGM67	4,144
G930	SMK HC	18
G940	SMK GREEN	7
G945	GRNSMY	16
G950	SMK RED	2
G963	HD RIOT CS	6
G982	GRNHNDPRAC	1
GG09	GRNSMKM90	2
H180	2.75M257	6,743
H181	2.75FLARE	501
H459	2.75FLECH	334
H463	2.75MPSMPR	2,145
H464	2.75MPSM	170
H490	2.75HEW/WH	4,943
H519	2.75WPRT	549
H557	66MMAT	95
H708	35MMSPL	1,005
H972	2.75HY70	1,834
H974	2.75HY70	4,005
H975	2.75HY70A	361
HA08	RKTASSLT83	8
HA13	2.75PRAC27	2,234
HA17	2.75PRSM26	113
J106	2.75FBAT	276
K030	IGNMNM39	67
K042	MA8MINE	0
K143	CLAYMORE	644
K180	M15AT	15
K181	M21MINE	21
K250	M19MINE	203
K765	CSGAS	880
K768	CS-1GAS	223
L307	SIG WHITE	22
L314	STARGRN	35
L598	FLASHBOOB	44
L601	SIMGRE	1,500

DOD Identification Code	Description of Ammunition	Quantity Fired
L602	ARTYSIM	55
M023	C4 1-1/4	7,807
M024	DEMOBLK	144
M028	BANGTORP	359
M031	TNT 1/2	892
M032	TNT 1LB	195
M034	DEMO CH	3,202
M039	40LB CRA	628
M130	BLCAPM6	100
M18A		84
M241	DESTM10	820
M420	SHAPCR15LB	317
M421	SHAPCR40LB	31
M448	DETPERC	52
M450	DETM1A2	1,475
M591	DYNAMITEM1	200
M642	60MMMORTHE	290
M670	TIMEFUSE	48
M766	PULLFUSE	3,049
M914	M68A2	18
M918	40MMTP	13,738
M998	DEMO CH	40
MD15	DETCORD-15	3,960
MD16	DETCORD-16	2,000
ML15	SHPD 225	180
ML47	CAPBLSTM11	44
MN02	CAPBLSTM12	5
MN06	CAPBLSTM14	236
MN08	CPBLSTM81	52
MS52	CORDDET	32,400
MS53	DETCORD-53	4,000
MS54	DETCORD-54	2,300
N285	FUSE577	47
PD68	HELFIRE114	24
PV04	TOWINERT	119
QA06	5.56MBAL	29,180
R112	7.62MMBLK	1,317
R113	5.56MM BLK	2,200
UN55	5.54	6,572
Z133	UKN	1,966
Z200	UKN	1,225
Z219	UKN	60,000

DOD Identification Code	Description of Ammunition	Quantity Fired
Z221	UKN	496
TOTAL ROUNDS:		12,885,522

Table 9. Munitions used in 2002 at Fort Knox, Kentucky.

DoD Identification Code	Description of Ammunition	Quantity Fired
A011	12GA,00BCK	3,146
A014	12GA, #7	251
A014	12GA, 7.5	480
A017	12GA, #9	1,140
A017	12GA,9	968
A059	5.56M/M855	1,162,431
A059	5.56M/M885	1,850
A060	5.56MBLK	800
A062	5.56MLINKD	22,210
A063	5.56MTM856	89,471
A064	5.56M4/1	585,722
A066	5.56MBAL	308,449
A068	5.56MTM196	19,849
A071	5.56M/M193	504,728
A072	5.56M,TR	12,129
A075	5.56MBLSAW	169,997
A080	5.56MBM200	268,471
A090	.22 CAL	3,970
A107	7.62M39BAL	2,500
A111	7.62MBLM82	126,156
A112	7.62MBM82	3,698
A127	7.62M,4/1	18,933
A130	7.62MBPACK	1,600
A131	7.62ML4/1	1,081,609
A136	7.62MBM118	520
A143	7.62MLKDB	115,813
A146	7.62MLTM62	4,200
A151	7.62MMLKD	188,820
A165	7.62MM4/1	58,200
A171	7.62 BALL	3,975
A254	762 SUBCAL	120
A257	7.62 LINK	115,000

DoD Identification Code	Description of Ammunition	Quantity Fired
A353	AT4SUBCAL	110
A358	9MM AT4	9,444
A358	AT4 9MM	11,797
A360	9MMB	72,636
A363	9MMBM882	209,858
A400	.38CALSPB	275
A404	.38CALSWAD	400
A475	.45CALBALL	20,275
A520	.50LKD4/IT	40,396
A540	.50 4&1A/T	28,624
A546	.50 BALL	2,100
A555	.50 BALL	5,959
A555	.50BALL	2,800
A557	.50 4&1B/T	87,981
A557	.50LKD4/IT	39,179
A576	.50 API	8,798
A585	.50 API-T	97
A587	.50 API-T	51,948
A598	.50 BLK	7,100
A599	.50 BLK	6
A662	20MM HEI	1,000
A940	25MMTPDS	14,400
A976	25MM TPT	28,133
AA06	5.56MM	4,000
AA06	50 CAL API	3,475
AA12	9MMSIMM	1,160
AA33	5.56M/M855	2,128,652
AA45	5.56MM	291,166
AA48	5.56MM	11,147
AA58	50 SLAP	57
B519	40MMTPM781	29,712
B535	40MM ILLUM	2,539
B542	40MMLKD430	3,864
B546	40MMHEDP	1,782
B568	40MMHEDO	490
B574	40MM HE	916
B576	40MMTPLKD	6,704
B584	40MMPRLKD	36,509
B629	60MMTP	52
B630	60MMWP	62
B643	60MM HE	296
BA02	40MM HEI	96
C256	81MMHE	276

DoD Identification Code	Description of Ammunition	Quantity Fired
C382	84 MM HE	5
C382	84MMHE	24
C383	84MM HEAT	54
C384	84MM ILLUM	29
C385	84MM SMK	34
C386	84MM TPT	157
C387	84MM HEDP	32
C432	105MM HE	393
C449	105MMILHOW	91
C511	105MM/M490	34
C520	105MMTPDST	55
C623	120 W/PD	122
C623	120MM745	63
C624	120MM SMK	48
C784	120 TP-T	1,382
C784	120MMTP-T	2,345
C785	120 TPCSDS	2,427
C785	120MMTPCSD	4,814
C789	120 SMK/WP	7
C868	81MM HE	531
C871	81MM ILLUM	69
C876	M203	47
C995	84MMAT4	92
D505	155MM ILL	195
D513	155MM TNG	1
D544	155MM HE	6
DWBS	FLASH BANG	230
G811	GRNM69	11
G878	GRNPRM228	44,457
G881	FRAGM67	6,479
G922	GRNRCCS	1
G940	SMK GREEN	240
G945	GRNSMY	186
G945	SMK YELLOW	17
G950	SMK RED	27
G955	SMKVIOL	114
G963	HD RIOT CS	28
G982	SMOKE	167
H163	HYDRA 70HE	376
H164	HYDRA 70	56
H557	66MMAT	557
H974	2.75HY70	92
H975	2.75HY70A	182

DoD Identification Code	Description of Ammunition	Quantity Fired
HA16	84MM HE	539
K143	CLAYMORE	226
L305	SIGGREENST	1
L306	SIGILLUM	17
L307	SIG WHITE	5
L311	PARAGRN	4
L312	PARAWHITES	1,606
L367	SIMLCHING	4
L495	TRIPSUR	240
L498	TUBEPRIM	198
L594	MK19	372
L594	SIM ARTY	25
L598	FLASHBOOB	29
L599	FLASHILLUM	13
L601	SIMGRE	819
L602	HOFFMAN	899
LASR	FLASHSIM	2,018
M023	C4 1-1/4	579
M024	DEMOBLK	8
M030	M1A4-1/4	769
M030C	TNT 1/4 LB	226
M031	TNT 1/2	293
M032	TNT 1LB	86
M039	40LB CRA	3
M130	BLCAPM6	840
M131	BLCAPM7	8,419
M420	SHAPCR15LB	3
M456	REINDET	5,706
M670	TIMEFUSE	664
M766	PULLFUSE	37
M918	40MMTP	160
M970	SUBCAL	230
ML45	BLCAP	66
ML47	M11 BL CAP	1,096
MN02	M12 BL CAP	189
MN06	MK19	553
MN08	MK19	580
MN11	TIMEFZE	4
MNO6	M14 BL CAP	869
MNO8	IGN FUSE	958
MS52	CORDDET	5
PB18	TOWPRA	16
PB94	TOW HEAT	3

DoD Identification Code	Description of Ammunition	Quantity Fired
PV04	TOWINERT	41
R112	7.62MMBLK	11,000
R113	5.56MM BLK	9,000
R116	ARTYSIM	1
X104	12HATTON	67
X281	7.62 MATCH	1,500
X551	DET	18
X577	SHKTUBE	18
X640	DEMOSHEET	6
TOTAL ROUNDS:		8,160,782

Table 10. Munitions used in 2002 at fort Polk, Louisiana.

DoD Identification Code	Description of Ammunition	Quantity Fired
A011	CTG, 12 GAGE M162 #0	5,476
A014	CTG, 12 GAGE #7 1/2	35,850
A015	CTG, 12 GAGE #8 SHOT	850
A017	CTG, 12 GAGE #9 SHOT	18,350
A020	CTG, 12 GAGE #4 SHOT	325
A046	CTG, 20 GAGE SKEET #	24,952
A058	CTG, 5.56MM BALL M85	16,435
A059	CTG, 5.56MM BALL M85	742,138
A062	CTG, 5.56MM BALL M85	118,400
A063	CTG, 5.56MM TR M856	64,277
A064	CTG, 5.56MM 4 BALL M	396,511
A065	CTG, 5.56MM SRTA BAL	56,868
A066	CTG, 5.56MM BALL M19	40,035
A068	CTG, 5.56MM TR M196	12,202
A070	CTG, 5.56MM HPT M197	3,028
A071	CTG, 5.56MM BALL M19	44,091
A072	CTG, 5.56MM TR M196	1,200
A073	CTG, 5.56MM 4 BALL M	3,927
A075	CTG, 5.56MM BLANK M2	146,534
A080	CTG, 5.56MM BLANK M2	147,505
A084	CTG, CAL .22 BALL SH	460
A086	CTG, CAL .22 BALL LR	47,331
A091	CTG, CAL .22 BALL LR	4,035
A093	CTG, CAL .22 BALL LR	1,850

DoD Identification Code	Description of Ammunition	Quantity Fired
A102	CTG, 7.62MM BALL F/A	420
A111	CTG, 7.62MM, BLANK,	126,487
A119	CTG, 7.62MM BALL M80	15,350
A127	CTG, 7.62MM 4 BALL M	22,800
A131	CTG, 7.62MM 4 BALL M	547,325
A136	CTG, 7.62MM BALL M11	8,067
A143	CTG, 7.62MM BALL M80	113,137
A165	CTG, 7.62MM 4 BALL M	24,000
A171	CTG, 7.62MM MATCH M8	2,107
A181	CTG, CAL .30 BALL M1	70
A246	CTG, CAL .30 BALL M7	528
A257	CTGS,7.62MM,9BALL M8	57,750
A358	CTG, 9MM TP-T M939 F	10,804
A362	CTG, 9MM BALL MK144	450
A363	CTG, 9MM BALL M882	148,131
A397	CTG, CAL .38 SPEC PG	1,280
A400	CTG, CAL .38 SPEC BA	50
A409	CTG, CAL .38 SPEC BA	960
A413	CTG, CAL .38 SPEC BA	1,800
A471	CTG, CAL .45 BALL MA	7,170
A475	CTG, CAL .45 BALL M1	36,857
A483	CTG, CAL .45 BALL M1	2,210
A520	CTG, CAL .50 4 BALL	14,148
A530	CTG, CAL .50 4 AP M2	500
A540	CTG, CAL .50 4 API M	28,903
A551	CTG, CAL .50 API/API	290
A552	CTG, CAL .50 BALL M2	3,813
A555	CTG, CAL .50 BALL M2	22,693
A557	CTG, CAL .50 4 BALL	255,866
A576	CTG, CAL .50 4 API M	4,023
A580	CTG, CAL .50 TR M1/M	4,906
A584	CTG, CAL .50 BALL M3	256
A598	CTG, CAL .50 BLANK M	4,147
A602	CTG, CAL .50 SRTA 4	3,479
A926	CTG, 20MM TP M55A2 L	1,497
A940	CTG, 25MM TPDS-T M91	12,857
A967	DUMMY CTG, 25MM, M28	73
A976	CTG, 25MM TP-T M793	5,789
AA11	CARTRIDGE,7.62MM NAT	758
AA33	CTG, 5.56MM, BALL, 1	516,436
AA49	CARTRIDGE, 9MM, BALL	44,875
B022	CTG, 30MM TP XM954 L	840
B103	CTG, 30MM 5 API PGU-	300

DoD Identification Code	Description of Ammunition	Quantity Fired
B104	CTG, 30MM HEI PGU-13	5,400
B116	CTG, 30MM TP PGU-15/	16,785
B118	CTG, 30MM TP M788 SN	2,240
B119	CTG, 30MM TP M788 LN	540
B477	CTG, 40MM WHT SMK CA	20
B504	CTG, 40MM GRN STAR P	378
B508	CTG, 40MM GRN SMK M7	227
B509	CTG, 40MM YLW SMK M7	241
B519	CTG, 40MM TP M781	28,798
B529	CTG, 40MM HE M383/HE	30
B535	CTG, 40MM ILLUM WHT	75
B542	CTG, 40MM HEDP M430	2,219
B546	CTG, 40MM HEDP M433	1,594
B554	CTG, 40MM HE-SD	653
B564	CTG, 40MM BL-T 4/CLI	12
B568	CTG, 40MM HE M406	63
B574	CTG, 40MM HE M386	173
B577	CTG, 40MM TP M407A1	88
B578	CTG, 40MM TP M387	1,129
B584	CTG, 40MM TP M918 LN	50,112
B627	CTG, 60MM ILLUM M83A	77
B630	CTG, 60MM SMK WP M30	40
B642	CTG, 60MM HE XM720	1,583
B643	CTG, 60MM HE M888	150
B646	CTG, 60MM SMK WP M72	40
B647	CTG, 60MM ILLUM M721	20
C009	CTG, IGN M285 F/81MM	30
C222	CTG, 81MM HE M362 SE	246
C234	CTG, 81MM SMOKE, WP,	80
C236	CTG, 81MM HE M374 SE	49
C256	CTG, 81MM HE M374 SE	1,481
C276	CTG, 81MM SMK WP M37	464
C382	CTG, 84MM HE, FFV 44	6
C384	CTG, 84MM, ILLUM, FF	6
C385	CTG, 84MM, SMOKE, FF	4
C434	CHG, PROP 105MM M1	149
C445	CTG, 105MM HE M1 W/O	2,981
C449	CTG, 105MM ILLUM M31	146
C479	CTG, 105MM SMK HC M8	415
C623	CTG, 120MM HE XM933	809
C624	CTG, 120MM SMK	595
C6XX	CTG, 120MM FRTR	111
C784	CTG, 120MM TP-T	499

DoD Identification Code	Description of Ammunition	Quantity Fired
C785	CTG, 120MM TPCSDS-T	953
C787	CTG, 120MM HEAT-MP-T	26
C788	CTG, 120MM HE M57 W/	36
C868	CTG 81MM HE M821 FZ	1,275
C870	CTG, 81MM SMK	120
C871	CTG, 81MM ILLUM M853	333
C995	CTG & LAUNCHER, 84MM	342
CA09	CARTRIDGE, 120MM FUL	50
D503	PROJ, 155MM HE RAAM-	68
D505	PROJ, 155MM ILLUM M4	102
D510	PROJ, 155MM HEAT M71	2
D528	PROJ, 155MM SMK WP M	110
D534	CHG, PROP 155MM WB M	3
D541	CHG, PROP 155MM WB M	76
D543	PROJ, 155MM H OR HD	17
D544	PROJ, 155MM HE M107	3,385
D545	PROJ, 155MM ILLUM M1	38
D548	PROJ, 155MM SMK HC M	5
D550	PROJ, 155MM SMK WP M	156
D554	PROJ, 155MM SMK VIO	6
E485	BOMB, GP 500 LB MK82	237
E969	BOMB, PRAC 25 LB BDU	535
F013	Bomb Practice BDU-50	48
F126	BOMB, GP 2000 LB MK8	2
F128	BOMB, GP 2000 LB MK8	2
F238	BOMB, GP 500 LB MK82	6
F275	BOMB, GP 2000 LB MK8	8
F281	BOMB, GP MK84	16
G878	FUZE, HAND GREN PRAC	2,842
G881	GRENADE, HAND FRAG M	910
G883	GRENADE, HAND FRAG M	53
G929	GRENADE, HAND RIOT S	44
G932	GRENADE, HAND SMK RE	48
G940	GRENADE, HAND SMK GR	446
G945	GRENADE, HAND SMK YL	357
G950	GRENADE, HAND SMK RE	3
G955	GRENADE, HAND SMK VI	487
G963	GRENADE, HAND RIOT C	4
G982	GRENADE, HAND, PRACT	726
G995	GRENADE, RIFLE SMK G	62
H162	ROCKET, 2.75 IN HE	128
H463	ROCKET, 2.75 IN MPSM	26
H583	ROCKET, HE. 2.75 INC	2

DoD Identification Code	Description of Ammunition	Quantity Fired
H828	ROCKET, 2.75 IN PRAC	12
H850	WARHEAD, SMK WP E12	4
H851	WARHEAD, HEDP XM247	21
H855	WARHEAD, SMK WP M156	87
H971	ROCKET, 2.75 IN IMPA	41
H972	ROCKET, 2.75 IN SMK	432
H974	ROCKET, 2.75" WHD M2	497
H975	ROCKET, 2.75" PRAC M	414
HA13	ROCKET, PRACTICE, 2.	297
J102	ROCKET MOTOR, 2.75 I	45
J143	ROCKET MOTOR, 5 IN M	3
K143	MINE, APERS M18A1 W/	451
K145	MINE, APERS M18A1 W/	5
K180	MINE, AT HEAVY M15	22
K181	MINE, AT HEAVY M21	67
K250	MINE, AT HEAVY M19 N	19
K758	RIOT CONTROL AGENT,	5
K765	RIOT CONTROL AGENT,	512
K768	RIOT CONTROL AGENT,	67
K861	SMOKE POT, GRND TYPE	4
K866	SMOKE POT, M5 HC (10	5
L119	SIGNAL KIT, PERS DIS	44
L307	SIGNAL, ILLUM GRND W	375
L311	SIGNAL, ILLUM GRND R	11
L312	SIGNAL, ILLUM GRND W	306
L314	SIGNAL, ILLUM GRND G	453
L367	SIMULATOR, ANTI-TANK	50
L425	FLARE, SURF AIRPORT	12
L495	FLARE, SURF TRIP PAR	197
L592	SIMULATOR, ANTI-TANK	8,600
L594	SIMULATOR, PROJ GRND	336
L598	SIMULATOR, EXPL BOOB	218
L599	SIMULATOR, EXPL BOOB	50
L600	SIMULATOR, BOOBY TRA	110
L601	SIMULATOR, HAND GREN	161
L602	SIM FLASH ARTY M21 9	1,540
L610	SIMULATOR, HAND GREN	20
L709	SIMULATOR, TARGET, H	10
L715	SIMULATOR, MISSILE M	137
L720	SIMULATOR, TARGET KI	58
M020	CHG, DEMO SHAPED MK4	1
M023	CHG, DEMO BLOCK M112	2,615
M024	CHG, DEMO BLOCK M118	50

DoD Identification Code	Description of Ammunition	Quantity Fired
M028	DEMO KIT, BANGALORE	181
M029	CHG, DEMO SHAPED FLE	14
M030	CHG, DEMO BLOCK TNT	36
M039	CHG, DEMO BLOCK 40 L	49
M046	CHG, DEMO LINEAR MK8	3
M110	CAP, BLASTING ELEC H	10
M420	CHG, DEMO SHAPED M2	33
M421	CHG, DEMO SHAPED M3	38
M431	CHG, DEMO SNAKE M2A1	109
M455	CORD, DET PETN	3,157
M456	CORD, DET, PETN, TYP	35,764
M457	CORD, DET, 1000 FT S	350
M670	FUZE, BLASTING TIME	300
M856	SQUIB, ELEC S-75	84
ML45	HOLDER, BLASTING CAP	1,343
ML47	CAP, BLASTING	2,521
MN02	CAP, BLASTING	139
MN03	CAP, BLASTING	247
MN06	CAP, BLASTING	839
MN08	IGNITER, TIME BLASTI	1,562
MN60	IGNITER, ELEC MATCH	206
MS60	CORD, DET SMDC	20
N285	FUZE, MTSQ M577/577A	520
N286	FUZE, MTSQ M582 MTL	330
N340	FUZE, PD M739 NON-PR	2,697
N464	FUZE, PROX M732	16
PB25	TOW TP	86
PB96	GUIDED MISSILE, PRAC	28
PB97	GUIDED MISSILE, SURF	5
PB99	GUIDED MISSILE, PRAC	9
PD62	GUIDED MISSILE, SURF	9
PE64	GUIDED MISSILE, PRAC	211
PL23	GUIDED MISSILE W/LNC	1
PU67	MISSILE,IMPROVED TOW	1
PV47	GUIDED MISSILE, SURF	79
X290	TACTICAL GRENADE, FL	525
X293	FUZE, MODEL M201FB	338
Z762	7.62MM SRTA BALL FRA	36,270
TOTAL ROUNDS:		4,228,179

Table 11. Munitions used in 2002 at Camp Shelby, Mississippi.

DoD Identification Code	Description of Ammunition	Quantity Fired
A010	10GA,BLKB	301
A011	12GA,00BCK	3,519
A017	12GA, #	36
A059	5.56M/M855	314,623
A062	5.56MLINKD	45,703
A063	5.56MTM856	7,507
A064	5.56M4/1B	62,100
A068	5.56MTM196	10,032
A071	5.56M/M193	15,042
A072	5.56M,TRB	500
A075	5.56MBLSAW	5,200
A080	5.56MBM200	3,000
A091	.22LMATCH	480
A107	7.62M39BAL	22,899
A111	7.62MBLM82	200
A127	7.62M,4/1	13,200
A130	7.62MBPACK	10,506
A131	7.62ML4/1	217,607
A131	7.62ML4/1|	46,520
A136	7.62MBM118	300
A140	7.62MTPACK	200
A143	7.62MLKDB	17,870
A151	7.62MMLKD	22,049
A165	7.62MM4/1	71,465
A181	.30C20CTB	200
A182	.30C10CLB	386
A353	AT4SUBCAL	250
A358	9MM AT4	2,300
A360	9MMBB	9,765
A360	9MMBB|	6,000
A363	9MMBM882B	50,913
A475	.45CALBALL	7,000
A520	.50 4&1	13,969
A546	.50 BAL	8,425
A555	.50 BAL	58,521
A557	.50 4&1	56,364
A576	.50 API	49,850
A587	.50 API	1,600
A602	.50 SRT	6,200
A652	20MMLKDTPT	4,875
A940	25MMTPDSB	60
A975	25MM HE	192

DoD Identification Code	Description of Ammunition	Quantity Fired
A976	25MM TP	1,032
AG01	SMKY SA	50
AG02	2.75 RX	246
B120	30MMTP	17,600
B470	40MMB	256
B470	40MMB|	75
B480	40MMTPHEL	227
B519	40MMTPM781	8,062
B535	40MM IL	44
B542	40MMLKD430	27,578
B546	40MMHEDPB	2,745
B576	40MMTPLKD	7,901
B584	40MMPRLKD	8,140
B584	40MMPRLKD|	1,344
B630	60MMWP	72
B642	60MMHE	1,319
B647	60MMILLUM	227
C226	81MMILLUM	514
C226	81MMILLUM|	18
C228	81MMHE	287
C256	81MMHE	408
C276	81MMSMKWP	30
C511	105MM/M490	28
C520	105MMTPDST	48
C623	120 W/P	18
C784	120 TP-	346
C785	120 TPC	554
C788	120 HE/	22
C789	120 SMK	24
C995	84MMAT4	124
D505	155MM I	310
D513	155MM T	447
D528	155MM S	265
D544	155MM H	6,044
D550	155MM C	123
D579	155MM H	77
E969	BDU33A/BB	2,310
F244	500LBMK82P	44
G900	GRNINCENB	4
G940	SMK GRE	32
G955	SMKVIOL	48
H108	MRLSPR	78
J143	MK22MIC/IC	4

DoD Identification Code	Description of Ammunition	Quantity Fired
K042	MA8MINE	24
K143	CLAYMOREB	39
L307	SIG WHI	12
L312	PARAWHITES	41
L314	STARGRN	12
L601	SIMGRE	115
L602	ARTYSIM	207
M023	C4 1-1/	1,390
M028	BANGTORPB	38
M030	M1A4-1/4B	367
M032	TNT 1LB	302
M034	DEMO CH	60
M039	40LB CR	40
M130	BLCAPM6	122
M131	BLCAPM7	136
M174	.50 CAL	32
M420	SHAPCR15LB	20
M421	SHAPCR40LB	11
M456	REINDET	5,580
M591	DYNAMITEM1	212
M670	TIMEFUSEB	310
M757	INCREM-16	1
M766	PULLFUSEB	9
M918	40MMTP	566
ML04	CUTTER	3
ML45		308
ML47		738
MN02		199
MN08		369
MNO6	BLAST C	185
PB96	TOWPRA	6
PL23	DRAGON	30
TOTAL ROUNDS:		1,268,338

Table 12. Munitions used in 2002 at Fort Leonard Wood, Missouri.

DoD Identification Code	Description of Ammunition	Quantity Fired Sept -Dec 2002	Annual Estimate of Quantity Fired [1]
A010	CTG, 10 GAGE BLANK F/37MM GUN	4,400	13,200
A011	CTG, 12 GAGE #00 BUCK	13,896	41,688
A058	CTG, 5.56MM BALL M855 SNGL RD	160,780	482,340
A059	CTG, 5.56MM BALL M855 10/CLIP	6,341,421	19,024,263
A062	CTG, 5.56MM BALL M855 LNKD	7,200	21,600
A063	CTG, 5.56MM TR M856 SNGL RD	6,900	20,700
A064	CTG, 5.56MM 4 BALL M855/1 TR M856 LNKD	1,027,203	3,081,609
A066	CTG, 5.56MM BALL M193 CTN PACK	55,750	167,250
A068	CTG, 5.56MM TR M196 CTN PACK	443,441	1,330,323
A070	CTG, 5.56MM HPT M197 SNGL RD	53,622	160,866
A071	CTG, 5.56MM BALL M193 10/CLIP	3,447,649	10,342,947
A073	CTG, 5.56MM 4 BALL M193/1 TR M196 LNKD	25,200	75,600
A075	CTG, 5.56MM BLANK M200 LNKD	295,530	886,590
A079	CTG, 5.56MM BLANK M755 F/GREN LNCHR	24,600	73,800
A080	CTG, 5.56MM BLANK M200 SNGL RD	732,016	2,196,048
A084	CTG, CAL .22 BALL SHORT	25,800	77,400
A085	CTG, CAL .22 SHORT BLANK	16,800	50,400
A086	CTG, CAL .22 BALL LR	40	120
A102	CTG, 7.62MM BALL F/AK47 SNGL RD	10,200	30,600
A110	CTG, 762MM BLANK M82	100	300
A111	CTG, 7.62MM, BLANK, M82, LNK	33,145	99,435
A131	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	21,600	64,800
A136	CTG, 7.62MM BALL M118 MATCH CTN PACK	15,755	47,265
A149	CTG, 7.62MM BALL M80 8/CLIP	16,000	48,000
A151	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	519,508	1,558,524
A165	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD F/M-GUN	18,000	54,000
A169	CTG, 7.62MM SHORT RANGE MATCH SNGL RD	10,000	30,000
A352	CTG, CAL .32 LINE THROWING	2,400	7,200
A358	CTG, 9MM TP-T M939 F/AT-4 TRNR	71,468	214,404
A363	CTG, 9MM BALL M882	1,139,592	3,418,776
A403	CTG, CAL .38 SPEC BLANK	450	1,350
A471	CTG, CAL .45 BALL MATCH	405	1,215
A598	CTG, CAL .50 BLANK M1E1 LNKD	2,600	7,800
A701	CTG, 20MM HEI M56A3 SERIES LNKD (04)	42,154	126,462
A894	CTG, 20MM TP M55A2 LNKD	30,000	90,000
AA29	CTG, SHOT GUN 12GAUGE, BEAN BAG	2,005	6,015
AA31	CTG, SHOTGUN 12 GAUGE, RUBBER FIN	2,005	6,015
AA33	CTG, 5.56MM BALL M855 10/CLIP	105,798	317,394
AA48	CTG 5.56MM Ball M855 C PAK-LF	3,843	11,529
AA49	CARTRIDGE, 9MM BALL M882	18,618	55,854
B116	CTG, 30MM TP PGU-15/B LNKD RHF	22,840	68,520

DoD Identification Code	Description of Ammunition	Quantity Fired Sept -Dec 2002	Annual Estimate of Quantity Fired [1]
B519	CTG, 40MM TP M781	54,780	164,340
B542	CTG, 40MM HEDP M430 LNKD (MK19) (04)	1,200	3,600
B584	CTG, 40MM TP M918 LNKD	78,052	234,156
BA07	CTG, 40MM FOAM RUBBER BATON	2,011	6,033
BA08	CTG, 40MM RUBBER BALL	426	1,278
C002	CTG, 75MM HE M334 (08)	3	9
C395	CANISTER, SMK GRN F/105MM M84	3	9
C995	CTG & LAUNCHER, 84MM M136 AT-4 (12)	92	276
DWBS	GRENADE, NON-LETHAL MK 141 CROWD CONTRL	703	2,109
E950	BOMB, PRAC MINIATURE MK23 MOD 1	24	72
E969	BOMB, PRAC 25 LB BDU-33 80/PL	6,455	19,365
G042	INITIATOR, BOMB FUZE	126	378
G874	FUZE, HAND GREN M201A1	1,122	3,366
G878	FUZE, HAND GREN PRAC M228	2,489	7,467
G880	GRENADE. HAND FRAG M61 (04)	404	1,212
G881	GRENADE, HAND FRAG M67 (04)	21,351	64,053
G922	GRENADE, HAND RIOT CS M47E3	32	96
G930	GRENADE, HAND SMK HC AN-M8	10	30
G932	GRENADE, HAND SMK RED M48E3	72	216
G940	GRENADE, HAND SMK GRN M18	826	2,478
G945	GRENADE, HAND SMK YLW M18	928	2,784
G950	GRENADE, HAND SMK RED M18	234	702
G955	GRENADE, HAND SMK VIO M18	968	2,904
G963	GRENADE, HAND RIOT CS M7 SERIES	643	1,929
G978	GRENADE LAUNCHER, SMOKE XM82 (02)	96	288
G982	GRENADE, HAND, PRACTICE	569	1,707
GG04	GRENADE, HAND, RUBBER BALL	703	2,109
H463	ROCKET, 2.75 IN MPSM PRAC W/WHD M267 (HYDRA) (04)	24	72
H663	2.75 inch Rocket Inert warhead	788	2,364
K001	ACTIVATOR, M1 F/AT MINE M15	14	42
K010	BRSTR, INCD M4	36	108
K042	MINE, CANISTER PRAC XM88 (VOLCANO)	48	144
K051	FUZE, M604 F/AT PRAC MINE M10A1, M12, M20	14	42
K121	MINE, APERS M14	42	126
K143	MINE, APERS M18A1 W/M57 FIRING DEVICE	186	558
K180	MINE, AT HEAVY M15 W/FUZE M603	12	36
K181	MINE, AT HEAVY M21 W/F M607	12	36
K250	MINE, AT HEAVY M19 NON-METALLIC W/FUZE M606	12	36
K511	SMOKE POT, FLOATING, PRACTICE	220	660
K765	RIOT CONTROL AGENT, CS CAPSULE	16	48
K917	THICKENING COMPOUND M4	64	192

DoD Identification Code	Description of Ammunition	Quantity Fired Sept -Dec 2002	Annual Estimate of Quantity Fired [1]
L108	DISPENSER, FLARE AIRCRAFT, SUU 40/A	100	300
L190	SIGNAL, ILLUM MARINE GRN STAR MK1 MOD 0	16	48
L213	SIGNAL, SMK MARINE RED MK21 MOD 0	160	480
L302	SIGNAL, ILLUM GRND WHT STAR F/LAU LX11	10	30
L305	SIGNAL, ILLUM GRND GRN STAR M195	22	66
L307	SIGNAL, ILLUM GRND WHT STAR CLUSTER M159	333	999
L311	SIGNAL, ILLUM GRND RED STAR PARA M126	50	150
L312	SIGNAL, ILLUM GRND WHT STAR PARA M127A1	6,259	18,777
L314	SIGNAL, ILLUM GRND GRN STAR CLUSTER M125A1	82	246
L316	SIGNAL, ILLUM GRND WHT STAR CLUSTER M18A1	14	42
L324	SIGNAL, SMK GRND GRN PARA M128A1	48	144
L441	FLARE, PARA LUU-2B/B	33	99
L495	FLARE, SURF TRIP PARA YLW M49 SERIES	312	936
L527	SIGNAL, SMK & ILLUM MARINE GRN-GRN MK39	10	30
L554	MARKER, LOCATION MARINE MK25 MODS	14	42
L592	SIMULATOR, ANTI-TANK LNCHR (TOW)	40	120
L594	SIMULATOR, PROJ GRND BURST M115A2 (04)	5,910	17,730
L595	SIMULATOR, PROJ AIR BURST M9 SPAL	15	45
L598	SIMULATOR, EXPL BOOBY TRAP FLASH M117	490	1,470
L599	SIMULATOR, EXPL BOOBY TRAP ILLUM M118	150	450
L600	SIMULATOR, BOOBY TRAP WHISTLING M119	1,005	3,015
L601	SIMULATOR, HAND GREN M116A1	4	12
L602	SIM FLASH ARTY M21 9/CT IN BG 162/B	8	24
M015	CTG, IMPULSE MK24 MOD 0	12	36
M023	CHG, DEMO BLOCK M112 1 1/4 LB COMP C-4	5,913	17,739
M028	DEMO KIT, BANGALORE TORP M1A2	151	453
M030	CHG, DEMO BLOCK TNT 1/4 LB	8,269	24,807
M032	CHG, DEMO BLOCK TNT 1 LB	938	2,814
M039	CHG, DEMO BLOCK 40 LB CRATERING	267	801
M117	CAP, BLASTING ELEC NO 7 DELAY	54	162
M118	CAP, BLASTING ELEC NO 8 DELAY	60	180
M127	CAP, BLASTING ELEC NO 8 DELAY	5	15
M420	CHG, DEMO SHAPED M2 SERIES 15 LB	133	399
M421	CHG, DEMO SHAPED M3 SERIES 40 LB	167	501
M455	CORD, DET PETN	150	450
M456	CORD, DET, PETN, TYPE 1 CL E (NEW=1000 FT)	281,368	844,104
M457	CORD, DET, 1000 FT SPOOL 2000 FT/B	2,000	6,000
M591	DYNAMITE, MILITARY M1	19,032	57,096
M832	CHG, DEMO SHAPED MK74 MOD 1	6	18
ML45	HOLDER, BLASTING CAP	361	1,083
ML47	CAP, BLASTING	2,659	7,977
MN02	CAP, BLASTING	2,167	6,501

DoD Identification Code	Description of Ammunition	Quantity Fired Sept -Dec 2002	Annual Estimate of Quantity Fired [1]
MN03	CAP, BLASTING	75	225
MN06	CAP, BLASTING	648	1,944
MN07	CAP, BLASTING	570	1,710
MN08	IGNITER, TIME BLASTING CAP	2,968	8,904
MN60	IGNITER, ELEC MATCH M79 350/BX	784	2,352
MN68	BOOSTER DEMO 10FT, DET CORD M15	7,941	23,823
MS48	CORD ASSEMBLY, DET F/COBRA SMDC	42	126
	TOTAL ROUNDS:	15,298,369	45,895,107

[1] An annual estimate of the quantity fired was calculated by multiplying the quantity fired in the four months of September through December 2002 by three.

Table 13. Munitions used in 2002 at Fort Bragg, North Carolina.

DoD Identification Code	Description of Ammunition	Quantity Fired
A010	CTG, 10 GAGE BLANK F/37MM GUN	1,000
A011	CTG, 12 GAGE #00 BUCK	17,998
A015	CTG, 12 GAGE #8 SHOT	9,700
A017	CTG, 12 GAGE #9 SHOT	12,337
A057	CTG, 28 GAGE SKEET #9 SHOT	2,000
A058	CTG, 5.56MM BALL M855 SNGL RD	20,574
A059	CTG, 5.56MM BALL M855 10/CLIP	7,906,961
A062	CTG, 5.56MM BALL M855 LNKD	1,484,222
A063	CTG, 5.56MM TR M856 SNGL RD	295,756
A064	CTG, 5.56MM 4 BALL M855/1 TR M856 LNKD	2,182,052
A065	CTG, 5.56MM BALL PRAC M862 SNGL RD, BLUE TIP	132,894
A066	CTG, 5.56MM BALL M193 CTN PACK	1,526,774
A068	CTG, 5.56MM TR M196 CTN PACK	51,780
A070	CTG, 5.56MM HPT M197 SNGL RD	3,820
A071	CTG, 5.56MM BALL M193 10/CLIP	735,863
A072	CTG, 5.56MM TR M196 10/CLIP	4,000
A073	CTG, 5.56MM 4 BALL M193/1 TR M196 LNKD	6,794
A075	CTG, 5.56MM BLANK M200 LNKD	896,623
A079	CTG, 5.56MM BLANK M755 F/GREN LNCHR	4,200
A080	CTG, 5.56MM BLANK M200 SNGL RD	70,544,270
A084	CTG, CAL .22 BALL SHORT	44,990
A085	CTG, CAL .22 SHORT BLANK	3,440
A088	CTG, CAL .22 HORNET SOFT POINT	4,994
A106	CTG, CAL .22 BALL LR STD VELOCITY	949

DoD Identification Code	Description of Ammunition	Quantity Fired
A110	CTG, 762MM BLANK M82	12,147
A111	CTG, 7.62MM, BLANK, M82, LNK	356,391
A112	CTG, 7.62MM BLANK M82 CTN PACK	43
A122	CTG, 7.62MM BALL M59/M80 CTN PACK	2,722
A128	CTG, 7.62MM BALL M80 LNKD	500
A130	CTG, 7.62MM BALL M59/M80 5/CLIP	57,905
A131	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	1,402,395
A136	CTG, 7.62MM BALL M118 MATCH CTN PACK	74,968
A140	CTG, 7.62MM TR M62 CTN PACK	4,580
A143	CTG, 7.62MM BALL M80 LNKD	366,317
A146	CTG, 7.62MM TR M62 LNKD	1,000
A149	CTG, 7.62MM BALL M80 8/CLIP	700
A151	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	18,300
A152	CTG, 7.62MM BALL M80 LNKD	4,000
A159	DUMMY CTG, 7.62MM, M60 LNKD	400
A164	CTG, 7.62MM BALL M80 LNKD F/MINIGUN	8,100
A165	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD F/M-GUN	58,958
A166	CTG, 7.62MM BALL M80 CTN PACK	1,840
A168	CTG, 7.62MM 9 BALL M80/1 TR M62 LNKD	5,000
A170	CTG, 7.62MM LONG RANGE MATCH SNGL RD	500
A171	CTG, 7.62MM MATCH M852 CTN PACK	122,228
A181	CTG, CAL .30 BALL M1 CTN PACK	2,000
A209	CTG, CAL .30 4 AP M2/1 TR M1 LNKD	10,000
A219	CTG, CAL .30 4 BALL M2/1 TR M1 BELTED	400
A236	CTG, CAL .30 TR M25 LNKD	7,000
A237	CTG, CAL .30 HPT M1 SNGL RD	2,300
A350	CTG, CAL .32 BALL AUTO	500
A358	CTG, 9MM TP-T M939 F/AT-4 TRNR	22,563
A363	CTG, 9MM BALL M882	2,173,865
A364	CTG, 9MM HPT XM905	364
A365	CTG, 14.5MM TRAINER M181 3 SEC DELAY	1,800
A471	CTG, CAL .45 BALL MATCH	570
A475	CTG, CAL .45 BALL M1911	8,400
A518	CTG, CAL .50, LNKD, 100 ROUND BELT	1,736
A519	CTG, CAL .50 SABOT LT ARMOR PENETRATOR "SLAP"	359
A530	CTG, CAL .50 4 AP M2/1 TR M17 LNKD	2,033
A531	CTG, CAL .50 API M8 AC SNGL RD	300
A540	CTG, CAL .50 4 API M8/1 TR M1/M17 LNKD	91,730
A542	CTG, CAL .50 API-T M20 MG CTN PACK	8,476
A546	CTG, CAL .50 BALL M2 LNKD	4,578
A552	CTG, CAL .50 BALL M2 CTN PACK	29,058
A554	CTG, CAL .50 BALL M2 LNKD	9,000

DoD Identification Code	Description of Ammunition	Quantity Fired
A555	CTG, CAL .50 BALL M2/M33 LNKD	110,330
A557	CTG, CAL .50 4 BALL M33/M2/1 TR M17/M10 LNKD	577,630
A559	CTG, CAL .50 BLANK M1 LNKD	321
A574	CTG, CAL .50 SPOTTER TR M48 SERIES SNGL RD	410
A576	CTG, CAL .50 4 API M8/1 API-T M20 LNKD	24,700
A580	CTG, CAL .50 TR M1/M17 CTN PACK	352
A584	CTG, CAL .50 BALL M33 LNKD	1,444
A596	CTG, CAL .50 4 AP M8/1 TR M1/M10/M17 LNKD	350
A598	CTG, CAL .50 BLANK M1E1 LNKD	12,737
A599	CTG, CAL .50 BLANK M1E1 LNKD	600
A603	CTG, CAL .50 BALL M858 LNKD	9,549
A664	CTG, 20MM 9 TP M55A2/1 TP-T M220 LNKD	1,140
A763	CTG, 20MM, TUNGSTEIN PENETRATOR, MK149, LKD	100
A940	CTG, 25MM TPDS-T M910 (08)	2,175
A976	CTG, 25MM TP-T M793 LNKD	2,420
AA11	CTG 7.62MM BALL	62,117
AA33	CTG, 5.56MM BALL M855 10/CLIP	1,905,506
B020	CTG, 30MM TP XM954 SNGL RD	2,900
B023	CTG, 30MM HEDP XM953 LNKD RHF (04)	4,600
B025	CTG, 30MM HPT XM956 SNGL RD (04)	1,600
B104	CTG, 30MM HEI PGU-13A/B LNKD RHF (04)	400
B113	CTG, 30MM TP MK4Z LNKD LHF	400
B118	CTG, 30MM TP M788 SNGL RD (M592 CNTR)	50,996
B120	CTG, 30MM TP M788 LNKD RHF	500
B127	CTG, 30MM HPT SNGL RD	200
B128	CTG, 30MM API-T PGU-14/B LNKD RHF	600
B129	CTG, 30MM HEDP M789 CTN PACK (04)	2,042
B131	CTG, 30MM HEDP M789 LNKD LHF (04)	600
B134	DUMMY CTG, 30MM	4,603
B137	CTG, 30MM TP M950 SNGL RD	400
B138	CTG, 30MM TP M950 LNKD RHF	600
B140	CTG, 30MM HEDP M949 SNGL RD (04)	52
B141	CTG, 30MM HEDP M949 LNKD RHF (04)	200
B144	CTG, 30MM HEDP XM952 LNKD LHF (04)	300
B470	CTG, 40MM HE M384 SERIES LNKD (12)	44
B481	CTG, 40MM HE M384/M684 LNKD	300
B504	CTG, 40MM GRN STAR PARA M661	920
B508	CTG, 40MM GRN SMK M715	400
B511	CTG, 40MM TP M813 4/CLIP (02)	132
B518	CTG, 40MM HE-PFPX M822 4/CLIP (04)	174
B519	CTG, 40MM TP M781	111,664
B529	CTG, 40MM HE M383/HE-T M677 LNKD F/HELI LNCHR	30

DoD Identification Code	Description of Ammunition	Quantity Fired
B535	CTG, 40MM ILLUM WHT STAR PARA M583	427
B536	CTG, 40MM ILLUM WHT STAR CLSTR M585	400
B542	CTG, 40MM HEDP M430 LNKD (04)	19,619
B546	CTG, 40MM HEDP M433 (PA120 MTL CNTR)	8,270
B557	CTG, 40MM HEI-SD 4/CLIP (08)	2,500
B558	CTG, 40MM HEI-T-NSD 4/CLIP (08)	24
B561	CTG, 40MM HE-P (08)	274
B563	CTG, 40MM BL-P (08)	40
B567	CTG, 40MM CHEM AGENT CS M651E1	32
B568	CTG, 40MM HE M406 (04)	8,399
B571	CTG, 40MM HE M383E1 LNKD (12)	7,950
B576	CTG, 40MM TP M385 LNKD	196
B578	CTG, 40MM TP M387 (04)	362
B584	CTG, 40MM TP M918 LNKD	134,314
B627	CTG, 60MM ILLUM M83A3 (08)	1,658
B630	CTG, 60MM SMK WP M302 SERIES (12)	884
B632	CTG, 60MM HE M49 SERIES (08)	746
B642	CTG, 60MM HE XM720 (08)	1,088
B643	CTG, 60MM HE M888 (08)	11,931
B645	CTG, 60MM TP SHORT M840	373
B646	CTG, 60MM SMK WP M722	824
B647	CTG, 60MM ILLUM M721 (08)	198
B653	REPAIR KIT, CTG, 60MM M840	25
C045	REPAIR KIT AMMO 81MM 7/B	120
C225	CTG, 81MM HE M43A1 W/PD FUZE M525 (08)	248
C226	CTG, 81MM ILLUM M301 SERIES (08)	617
C227	CTG, 81MM TP M43A1 W/PD FUZE (08)	7
C230	CTG, 81MM SMK WP M57/57A1 W/PD FUZE (12)	20
C236	CTG, 81MM HE M374 SERIES W/O FUZE (08)	202
C256	CTG, 81MM HE M374 SERIES W/PD FUZE (08)	1,711
C275	CTG, 90MM APER-T M580 SERIES (12)	10
C276	CTG, 81MM SMK WP M375 W/PD FUZE (12)	1,021
C279	CHG, PROP M90A1 F/81 MM	80
C282	CTG, 90MM HEAT M371A1 (12)	248
C353	CTG, 3 IN 50 CAL VT FCL MK31 FLASHLESS (08)	1,000
C380	CTG, 120MM APFSDS-T M829A1 (08)	438
C382	CTG, 84MM HE, FFV 441B FOR RAAWS	50
C410	CTG, 90MM CANISTER APER M5 (08)	2
C440	CTG, 105MM BLANK M395	4
C444	CTG, 105MM HE M1 W/PD FUZE (12)	1,501
C445	CTG, 105MM HE M1 W/O FUZE (12)	25,515
C448	CTG, 105MM HEP-T M327	28
C449	CTG, 105MM ILLUM M314 SERIES (08)	1,877

DoD Identification Code	Description of Ammunition	Quantity Fired
C452	CTG, 105MM SMK HC M84 SERIES (12)	286
C454	CTG, 105MM SMK WP M60 SERIES (12)	378
C463	CTG, 105MM HE RAP XM548 (12)	87
C477	CTG, 105MM SMK WP M60 SERIES W/O FUZE (12)	55
C479	CTG, 105MM SMK HC M84A1 (12)	487
C542	CTG, 105MM ILLUM M314A3 1/CNT	12
C601	CTG, 90MM CANISTER APER M377 (08)	2
C623	CTG, 120MM HE XM933	1,688
C650	CTG, 106MM HEAT M344A1 W/PIBD FUZE (12)	195
C660	CTG, 106MM APERS-T M581 (12)	2
C697	CTG, 4.2 IN HE M329A2 W/O FUZE	64
C784	CTG, 120MM TP-T	411
C785	CTG, 120MM TPCSDS-T M865 (METAL CNTR) (08)	823
C788	CTG, 120MM HE M57 W/FUZE PD M935 (08)	377
C868	CTG 81MM HE M821 FZ M734 2/B, M984 3/CNT	6,341
C870	CTG, 81MM SMK	113
C871	CTG, 81MM ILLUM M853A1 W/FUZE MTSQ M772 (04)	572
C876	CTG, 81MM, M880	838
C877	CTG, 81MM HE, M983 W/FUZE, PD	9
C878	CTG, 81MM HE, M984 W/FUZE MULTI-OPTION	348
C995	CTG & LAUNCHER, 84MM M136 AT-4 (12)	1,343
D454	CANISTER, SMK YLW M4 F/155MM M116	10
D505	PROJ, 155MM ILLUM M485 SERIES	1,420
D510	PROJ, 155MM HEAT M712 (COPPERHEAD)	11
D514	PROJ, 155MM HE RAAM-S M741A1	21
D528	PROJ, 155MM SMK WP M825 (02)	310
D529	PROJ, 155MM HE M795 (18)	26
D534	CHG, PROP 155MM WB M119/119E4 W/PRIMER	13
D540	CHG, PROP 155MM GB M3 SERIES	199
D541	CHG, PROP 155MM WB M4 SERIES	84
D543	PROJ, 155MM H OR HD M110 (12)	24
D544	PROJ, 155MM HE M107 (18)	16,677
D545	PROJ, 155MM ILLUM M118	79
D550	PROJ, 155MM SMK WP M105/M110 SERIES (12)	291
D554	PROJ, 155MM SMK VIO M116	17
D579	PROJ, 155MM HE RAP M549 SERIES (COMP B) (18)	32
E480	BOMB, GP 500 LB MK82 MOD 1	10
E969	BOMB, PRAC 25 LB BDU-33 80/PL	1,823
F126	BOMB, GP 2000 LB MK84 MOD 2	4
F238	BOMB, GP 500 LB MK82 MOD 1 MINOL	6
G811	BODY, PRACTICE HAND GRENADE f/M69	4,064

DoD Identification Code	Description of Ammunition	Quantity Fired
G840	CTG, GREN MRTR TNG CAL .22	4
G878	FUZE, HAND GREN PRAC M228	21,064
G880	GRENADE. HAND FRAG M61 (04)	242
G881	GRENADE, HAND FRAG M67 (04)	11,740
G892	GRENADE, HAND FRAG MK2A1	2
G900	GRENADE, HAND INCD TH-3 AN-M14	216
G910	GRENADE, HAND OFFENSIVE MK3 SERIES	60
G918	GRENADE, HAND PRAC M69	2
G930	GRENADE, HAND SMK HC AN-M8	11
G940	GRENADE, HAND SMK GRN M18	631
G945	GRENADE, HAND SMK YLW M18	357
G950	GRENADE, HAND SMK RED M18	455
G955	GRENADE, HAND SMK VIO M18	171
G963	GRENADE, HAND RIOT CS M7 SERIES	3
G980	GRENADE, RIFLE PRACTICE	24
G982	GRENADE, HAND, PRACTICE	2,530
G995	GRENADE, RIFLE SMK GRN M22	22
H108	ROCKET POD, 298MM PRACTICE M28 (MLRS)	81
H115	ROCKET, 2.75 IN SMK WP W/WHD M156 (HYDRA-70)	110
H162	ROCKET, 2.75 IN HE	294
H163	ROCKET, 2.75 IN HE W/WHD M151 (HYDRA)	224
H185	ROCKET, POD, REDUCED RANGE PRAC. M28A1 MLRS	289
H305	ROCKET MOTOR, M3 OR M3A2	2
H459	ROCKET, 2.75 IN APER W/FLECHETTE WHD WDU-4A/A	28
H463	ROCKET, 2.75 IN MPSM PRAC W/WHD M267 (HYDRA) (04)	472
H485	ROCKET, 2.75 IN HE	39
H490	ROCKET, 2.75 IN HE W/WHD M151	2,157
H513	ROCKET, 2.75 IN PRAC	88
H554	ROCKET, 66MM HE M72A1	65
H557	ROCKET, 66MM HEAT M72A2	346
H828	ROCKET, 2.75 IN PRAC W/WHD WTU-1/B (12)	3,045
H913	WARHEAD, HE MK78-0 F/5 IN RCKT	50
H971	ROCKET, 2.75 IN IMPACT SIG PRAC W/MK40 4/CNT	67
H972	ROCKET, 2.75 IN SMK PRAC M274 (HYDRA)	342
H973	ROCKET, 2.75 IN IMP SIG PRAC M274 WHD 4/CNT	100
H974	ROCKET, 2.75" WHD M267, FZ M439, MTR MK66 MOD3 (04)	5,432
H975	ROCKET, 2.75" PRAC M274 MK66 MOD 3	6,417
HX05	ROCKET, 83MM ASSAULT MK3 MODS (SMAW)	3
J143	ROCKET MOTOR, 5 IN MK22 MOD 4 (FOR MICLIC)	2

DoD Identification Code	Description of Ammunition	Quantity Fired
K040	CHG, SPOTTING F/MINE AP PRAC M8	4
K055	Fuze, Mine Comb.	24
K143	MINE, APERS M18A1 W/M57 FIRING DEVICE	1,343
K180	MINE, AT HEAVY M15	242
K181	MINE, AT HEAVY M21	187
K250	MINE, AT HEAVY M19 NON-METALLIC	159
K866	SMOKE POT, M5 HC (10-20 MIN BURN)	41
K917	THICKENER, M4	53
L301	SIGNAL, SMK GRND MARINE F/LUU-10/B	5
L302	SIGNAL, ILLUM GRND WHT STAR F/LAU LX11	1
L305	SIGNAL, ILLUM GRND GRN STAR M195	35
L306	SIGNAL, ILLUM GRND RED STAR CLUSTER M158	29
L307	SIGNAL, ILLUM GRND WHT STAR CLUSTER M159	193
L311	SIGNAL, ILLUM GRND RED STAR PARA M126	29
L312	SIGNAL, ILLUM GRND WHT STAR PARA M127A1	291
L314	SIGNAL, ILLUM GRND GRN STAR CLUSTER M125A1	186
L351	SIMULATOR, PROJ AIR BURST M27A1B1	1
L367	SIMULATOR, ANTI-TANK WPNS EFFECT M22 (ATWESS)	4
L411	FLARE, ACFT PARA LUU-2B/LUU-2A/B	10
L442	FLARE, ACFT PARA LUU-2B/B	8
L495	FLARE, SURF TRIP PARA YLW M49 SERIES	36
L508	FLARE, WARNING RR SIGNAL RED M72	10
L584	MARKER, LOCATION MARINE MK38 MOD 1	592
L588	MARKER, LOCATION MARINE YLW MK77 MOD 0	20
L592	SIMULATOR, ANTI-TANK LNCHR (TOW)	59
L594	SIMULATOR, PROJ GRND BURST M115A2 (04)	522
L596	SIMULATOR, FLASH ARTY M110	16
L598	SIMULATOR, EXPL BOOBY TRAP FLASH M117	119
L599	SIMULATOR, EXPL BOOBY TRAP ILLUM M118	25
L600	SIMULATOR, BOOBY TRAP WHISTLING M119	61
L601	SIMULATOR, HAND GREN M116A1	528
L603	SIMULATOR, FLASH ARTY XM24	3
L605	SIMULATOR, ATOMIC EXPLOSION M142	40
L720	SIMULATOR, TARGET KILL M26 60/B	40
M008	CTG, IMPULSE M270	8
M009		12
M023	CHG, DEMO BLOCK M112 1 1/4 LB COMP C-4	23,847
M024	CHG, DEMO BLOCK M118 2 LB PETN	155
M025	CHG, DEMO LINEAR M58 COMP C-4	107
M026	DEMO KIT, BANGALORE TORP M1A1	345
M028	DEMO KIT, BANGALORE TORP M1A2	1,436
M030	CHG, DEMO BLOCK TNT 1/4 LB	1,330

DoD Identification Code	Description of Ammunition	Quantity Fired
M032	CHG, DEMO BLOCK TNT 1 LB	3,498
M039	CHG, DEMO BLOCK 40 LB CRATERING	757
M078	CAP, BLASTING, ELEC M4	24
M093	CAP, BLASTING ELEC NO 13 DELAY	2
M104	CAP, BLASTING ELEC NO 4 DELAY	2
M107	CAP, BLASTING ELEC NO 5 DELAY	3
M108	CAP, BLASTING ELEC NO 6 DELAY	1
M118	CAP, BLASTING ELEC NO 8 DELAY	58
M125	CAP, BLASTING, ELEC NO. 8	2
M130	CAP, BLASTING ELEC M6	1,689
M131	CAP, BLASTING NON-ELEC M7	3,943
M138	CAP, BLASTING ELEC HIGH ALTITUDE E81	2
M174	CTG, .50 CAL BLANK ELEC INIT	157
M241	DESTRUCTOR, EXPL UNIVERSAL M10	52
M327	COUPLING BASE, FIRING DEVICE W/PRIMER	5
M420	CHG, DEMO SHAPED M2 SERIES 15 LB	234
M421	CHG, DEMO SHAPED M3 SERIES 40 LB	736
M450	DETONATOR, PERC M1A2 15 SEC DELAY	8
M455	CORD, DET PETN	2,000
M456	CORD, DET, PETN, TYPE 1 CL E (NEW=1000 FT)	234,166
M521	CTG, IMPULSE MK82 MOD 0	4
M591	DYNAMITE, MILITARY M51	1,987
M613	CORD, DET	1,725
M617	FIRING DEVICE, DEMO ASSORTED DELAY	11
M626	FIRING DEVICE, DEMO PRESSURE M1A1	12
M667	CTG, IMPULSE	100
M670	FUZE, BLASTING TIME M700	21,204
M726	INITIATOR, CTG ACTUATED	6
M727	INITIATOR, CTG ACTUATED	68
M756	CHG, ASSY DEMO M37	22
M757	CHG, ASSY DEMO M183 COMP C-4 8 X 2 1/2 LB	167
M763	INITIATOR, PROP INITIATED M113	180
M766	IGNITER, M2/M60 F/TIME BLASTING FUSE	4,357
M769	CTG, DELAY CCU-4/A	5
M855	CAP, BLASTING ELEC	20,047
M865	CANISTER, CTG ACTUATED M1A2	9
M880	CANISTER, CTG ACTUATED M9	2,540
M881	CANISTER, CTG ACTUATED M13	1,000
M928	ROCKET MOTOR, MK82 MOD 0	128
M929	ROCKET MOTOR, MK83 MOD 0	40
M933	ROCKET MOTOR, MK92 MOD 0/1	46
M934	IGNITION ELEMENT, ELEC	18
M939	ROCKET MOTOR, MK87 MOD 0	1,133

DoD Identification Code	Description of Ammunition	Quantity Fired
M977	CORD, DET LIGHTWEIGHT 2000 FT/B	351
M995	CHG, DEMO RIGID LINEAR MK86 MOD 0	30
ML03	FIRING DEVICE, DEMO MULTI-PURPOSE M142	86
ML04	CUTTER, HE MK23 MOD 0	18
ML11	CHG, DEMO FLEX LINEAR SHAPED 40 GR/FT	7
ML13	CHG, DEMO FLEX LINEAR SHAPED 75 GR/FT	14
ML15	CHG, DEMO FLEX LINEAR SHAPED 225 GR/FT	60
ML45	HOLDER, BLASTING CAP	392
ML47	CAP, BLASTING, NON-ELEC, 30 FT.	7,283
MM26	CHG, DEMO, TUBE 200/BX	22
MM35	CHG, DEMO, LINEAR SHAPED 6FT	10
MM51	CHG, DEMOLITION (NEW = 600 GRAINS PER FOOT)	8
MN02	CAP, BLASTING, NON-ELEC, 500 FT.	4,282
MN03	CAP, BLASTING, NON-ELEC, 1000 FT.	7,282
MN06	CAP, BLASTING, DEL, M14	4,021
MN07	CAP, BLASTING, NON-ELEC, 25 SEC.	161
MN08	IGNITER, TIME BLASTING CAP, M81	5,128
MN11	TIME DEL FIRING DEVICE	174
MS56	CORD ASSEMBLY, DET F/COBRA SMDC	500
MU42	CORD, DET 100 GRAIN	1,500
N384	FUZE, TIME M84	50
NONE	NOT APPLICABLE	2
PB18	GUIDED MISSILE, SURF ATTACK PRAC BTM-71-A STD RANGE (TOW)	34
PB25	TOW TP	20
PE63	GUIDED MISSILE, PRAC BTM-71A-2A STD RANGE (TOW)	1
PE64	GUIDED MISSILE, PRAC BTM-71A-3A EXT RANGE (TOW)	214
PL34	GUIDED MISSILE SURFACE ATTACK AAWS-M (JAVELIN)	4
X100	500 LB PRACTICE BOMB	4
X236	SIM-MUNITIONS, RED	49,455
X237	SIM-MUNITIONS, BLUE	12,740
Z204	7.62 x 39mm rifle blank	6,200
Z219	85mm	212
TOTAL ROUNDS:		94,433,096

Table 14. Munitions used in 2002 at Fort Sill, Oklahoma.

DoD Identification Code	Description of Ammunition	Quantity Fired
G878	FUZE, HAND GREN PRAC M228	NI
G881	GRENADE, HAND FRAG M67	NI
G900	GRENADE, HAND INCD TH-3 AN-M14	NI
G940	GRENADE, HAND SMK GRN M18	NI
G945	GRENADE, HAND SMK YLW M18	NI
G950	GRENADE, HAND SMK RED M18	NI
G955	GRENADE, HAND SMK VIO M18	NI
G963	GRENADE, HAND SMK RIOT CS M7	NI
G982	GRENADE, HAND PRAC SMK TA XM83	NI
K866	FUZE, SMOKE POT M209 ELEC	NI
A010	CTG, 10 GAGE BLANK F/37MM	NI
A011	CTG, 12 GAGA #00 BUCK	NI
A059	CTG, 5.56MM BALL M855 10/CLIP	NI
A062	CTG, 5.56MM BALL M855 LNKD	NI
A063	CTG, 5.56MM TR M856 SNGL RD	NI
A064	CTG, 5.56MM 4 BALL M855/1 TR M856 LNKD	NI
A066	CTG, 5.56MM BALL M193 CTN PACK	NI
A068	CTG, 5.56MM TR M196 CTG PACK	NI
A071	CTG, 5.56MM BALL M193 10/CLIP	NI
A075	CTG, 5.56MM BLANK M200 LNDK	NI
A080	CTG, 5.56MM BLANK M200 SNGL RD	NI
A111	CTG, 7.72MM BLANK M82 LNKD	NI
A131	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	NI
A136	CTG, 7.62MM BALL M118 MATCH CTN PACK	NI
A143	CTG, 7.62MM BALL M80 LNKD	NI
A151	CTG, 7.62MM 4 BALL M80/1 TR M62 LNKD	NI
A164	CTG, 7.62MM BALL M80 LNKD	NI
A678	CTG, 7.62MM BALL M80 8/CLIP	NI
A358	CTG, 9MM TP-T M939 F/AT-4 TRNR	NI
A363	CTG, 9MM BALL M882	NI
A555	CTG, CAL .50 BALL M2/M33 LNKD	NI
A557	CTG, CAL .50 4 BALL M33/M2/1 TR M17/M10 LNKD	NI
A598	CTG, CAL .50BLANK M1E1 LNKD	NI
AA33	CTG, 5.56MM BALL M855 10/CLIP COM PACK	NI
AA49	CTG, 9MM Ball COM PACK	NI
B519	CTG, 40MM TP M781	NI
B546	CTG, 40MM HEDP M433 (PA120 MTL CNTR)	NI
B584	CTG, 40MM TP M918 LNKD	NI
C025	CTG, 75MM BLANK M337A2	NI
C440	CTG, 105MM BLANK M395	NI
C445	CTG, 105MM HE M1 W/O FUZE	NI
C449	CTG, 105MM ILLUM M314 SERIES	NI
C454	CTG, 105MM SMK WP M60 SERIES	NI

DoD Identification Code	Description of Ammunition	Quantity Fired
C479	CTG, 105MM SMK HC M84A1	NI
D505	PROJ, 155MM ILLUM M485	NI
D510	PROJ, 155MM HEAT M712 (COPPERHEAD)	NI
D528	PROJ, 155MM SMK WP M825	NI
D540	CHG PROP 155MM GB M3	NI
D541	CHG PROP 155MM WB M4	NI
D544	PROJ 155MM HE M107	NI
D550	PROJ 155MM WP M105/M110	NI
E511	BOMB, INERT PRACTICE 1000LB, MK-83	NI
E969	BOMB, PRACTICE 25LB, BDU-33	NI
F013	BOMB, INERT PRACTICE 500LB, BDU-50	NI
F470	CTG, SIGNAL PRAC BOMB CXU 3A/B	NI
F562	CTG, SIGNAL PRAC BOMB MK-4 MOD 3	NI
H185	RCKT POD, 298MM PRACTICE M28A1 RR (MLRS)	NI
K143	MINE, APERS M18A1 W/M57 FIRING DEVICE	NI
K145	MINE, APERS M18A1 W/0 FIRING DEVICE	NI
K765	RIOT CONTROL AGENT, CS-2	NI
L305	SIGNAL, ILLUM GRND GRN STAR M195	NI
L306	SIGNAL, ILLUM GRND RED STAR CLUSTER M158	NI
L307	SIGNAL, ILLUM GRND WHT STAR CLUSTER M159	NI
L311	SIGNAL, ILLUM GRND RED STAR PARA M126	NI
L312	SIGNAL, ILLUM GRND WHT STAR PARA M127A1	NI
L314	SIGNAL, ILLUM GRND GRN STAR CLUSTER M125A1	NI
L495	FLARE, SURF TRIP PARA YLW M49	NI
L594	SIMULATOR, PROJ GRND BURST M115A2	NI
L595	SIMULATOR, PROJ AIR BURST M9 SPAL	NI
L598	SIMULATOR, EXPL BOOBY TRAP FLASH M117	NI
L599	SIMULATOR, EXPL BOOBY TRAP ILLUM M118	NI
L600	SIMULATOR, BOOBY TRAP WHISTLING M119	NI
L601	SIMULATOR, HAND GREN M116A1	NI
M030	CHG, DEMO BLOCK TNT 1/4 LB	NI
M130	CAP, BLASTING ELECT M6	NI
M587	DYNAMITE, GELATIN 40%	NI
MN32	DYNAMITE, 60% AMMONIUM NITRATE (NEW/STICK)	NI
N278	FUZE, MTSQ M564	NI
N285	FUZE, MTSQ M577A1	NI
N286	FUZE, MTSQ M582	NI
N289	FUZE, ELECTRONIC TIMR M762	NI
N290	FUZE, ET M767	NI
N335	FUZE, PD M557	NI
N340	FUZE, PD M739	NI
N464	FUZE, PROX M732	NI
N523	PRIMER, PERC M82	NI
Note: NI = No Information		

Table 15. Munitions used in 2002 at Fort Jackson, South Carolina.

DoD Identification Code	Quantity Fired
A011	13,396
A017	4,150
A059	3,514,104
A062	61,520
A063	4,821
A064	1,389,360
A066	7,810,361
A068	283,692
A071	3,099,373
A073	61,934
A075	2,400
A080	906,658
A111	1,405
A112	60
A129	0
A130	45
A131	38,643
A136	500
A143	8,122
A146	4,940
A151	573,859
A164	8,000
A171	3,275
A358	135,373
A363	106,498
A540	2,573
A555	4,863
A557	61,200
A584	970
A940	1,448
A976	1,777
AA11	100
AA33	3,058,786
AA49	12,272
B120	0
B519	80,202
B542	84
B546	689
B568	64
B576	575
B584	7,011
C025	42

DoD Identification Code	Quantity Fired
C226	42
C256	74
C276	20
C995	195
D505	82
D528	43
D541	60
D544	848
D550	3,080
G811	1
G878	269,785
G881	42,795
G882	2
G900	411
G922	1
G930	
G932	172
G940	180
G945	186
G950	6
G955	295
G963	18
G982	4,255
J143	1
K143	12
K145	356
K765	4,095
L306	224
L307	16
L312	4,042
L495	36
L594	2,243
L596	5
L598	7
L599	23
L601	203
M023	508
M028	2
M039	5
M116	2
M420	30
M456	2,000
M914	1

DoD Identification Code	Quantity Fired
ML45	265
ML47	300
MN02	39
MN03	26
MN06	293
MN08	250
N340	60
TOTAL ROUNDS	21,602,740

Table 16. Munitions used in 2002 at Camp Bullis, Texas.

DoD Identification Code	Quantity Fired
A011	7,793
A017	150
A020	760
A059	22,536
A062	1,524,165
A063	10,764
A070	12,930
A071	699,180
A072	43,253
A073	23,590
A080	200
A091	1,050
A093	1,300
A102	33,000
A106	500
A119	501
A127	200
A128	2,397,251
A130	500
A136	59,188
A169	300
A171	602
A321	1,300
A360	3,050
A362	850
A363	337,993
A366	100

DoD Identification Code	Quantity Fired
A400	1,850
A413	250
A415	100
A471	3,350
AAAA	43,886
B480	371
B519	4,112
BBBB	400
G880	102
G881	12,901
G883	207
H708	393
K143	86
M023	121
M043	150
M097	10
M098	10
M418	21
Z084	100
TOTAL ROUNDS: 5,251,426	

Table 17. Munitions used in 2002 at Fort Hood, Texas.

DoD Identification Code	Description of Ammunition	Quantity Fired
15SG	STINGER TM GRENADE	10,600
23BR	BEAN BAG ROUND 12 GUAGE	3,200
40A	DETERGENT MARKING ROUND	48
A011	CTG, 12 GAGE SHOTGUN, #00 BUCK	184
A017	CTG, 12 GAGE SHOTGUN, #9	100
A055	CTG, 410 GAGE M35 #6 SHOT	840
A058	CTG, 5.56MM BALL M855 SNGL RD	1,030
A059	CTG, 5.56MM BALL, M855 10/CLIP	1,445,114
A060	CTG, 5.56MM DUMMY, M199 CTN PK	1,440
A062	CTG, 5.56MM BALL M855 LINKED	268,532
A063	CTG, 5.56MM TRACER M856/M16A2	144,702
A064	CTG, 5.56MM 4/1, 855/856, M249	515,162
A065	CTG, 5.56MM BALL PRAC M862 SNGL RD	9,460
A066	CTG 5.56MM BALL	490,787
A068	CTG 5.56MM TRACER RIFLE M196	2,200

DoD Identification Code	Description of Ammunition	Quantity Fired
A070	CTG, 5.56MM HPT M197 SNGL RD	800
A071	CTG 5.56MM BALL M193	108,515
A075	CTG 5.56MM BLANK LKD SAW	20,661
A080	CTG 5.56MM BLANK M200	52,870
A111	CTG 7.62MM BLANK LINKED M82	14,181
A130	CTG 7.62MM BALL CT PACK	2,600
A131	CTG 7.62MM LKD 4BALL&1TRACER	1,257,189
A136	CTG 7.62MM BALL M118	2,430
A143	CTG 7.62MM LKD BALL	279,020
A146	CTG 7.62MM LINKED TRACER M62	4,850
A165	CTG 7.62MM LKD 4BALL&1TRACER	3,000
A171	7.62MM MATCH M852	840
A353	CTG 9MM TRACER SUBCAL FOR AT4	2,179
A358	CTG 9MM TRACER SUBCAL FOR AT4	9,880
A363	CTG 9MM BALL M882	395,890
A519	CTG.CAL.50 SABOT LT ARMOR PENE	60
A531	CTG, CAL .50 API M8 AC SNGL RD	782
A540	CTG CAL.50 LKD 4API & 1TRACER	66,360
A546	CTG CAL.50 BALL	700
A550	CTG, CAL .50 AP/API-T LNKD	150
A551	CTG, CAL .50 API/API-T M8/M1/M20 LNKD	2,000
A552	CTG, CAL .50 BALL M2 CTN PACK	3,355
A554	CTG, CAL .50 BALL M2 LNKD	2,000
A555	CTG. CAL .50 BALL M2	69,973
A557	CTG CAL.50 LKD 4 BALL & 1 TR	520,264
A576	CTG CAL.50 LKD 4API&1API-T	12,310
A577	CTG, CAL .50 4 API M8/1 API-T M20 LNKD	12
A583	CTG, CAL .50 4 BALL M2/1 TR M1 LNKD	9,343
A584	CTG, CAL .50 BALL M33 LNKD	937
A596	CTG, CAL .50 4 AP M8/1 TR M1/M10/M17 LNKD	449
A675	CTG, 20MM APDS M103/MK149 LNKD RHF (04)	1,584
A940	CTG 25MM TPDS-T M910	84,481
A967	DUMMY CTG, 25MM, M28 LNKD	634
A974	CTG 25MM APDS-T	30
A975	CTG 25MM HEI-T	30
A976	CTG 25MM TPT	66,161
A979	CTG, 25MM API PGU-20/U SNGL RD	173
AA33	CTG, 5.56MM BALL M855 CLIP	647,555
AX11	9MM SUBCAL FOR SMAW	50
B110	CTG, 30MM TP T239 SNGL RD (04)	6,031
B113	CTG, 30MM TP MK4Z LNKD LHF	3,580
B118	CTG, 30MM TP M788 SNGL RD (M592 CNTR)	42,882
B516	TRACER, PROJ MK11 MOD 0 F/40MM	300

DoD Identification Code	Description of Ammunition	Quantity Fired
B519	CTG 40MM TP M781	40,032
B535	CTG 40MMILLUM WHITESTAR PARACH	31
B542	CTG 40MM HEDP M430 LKD	500
B545	CTG, 40MM BLANK SALUTING	2,303
B546	CTG 40MM HE DUAL PURPOSE	2,355
B557	CTG, 40MM HEI-SD 4/CLIP (08)	100
B568	CTG 40MMHE DUAL PURPOSE	83
B584	CTG 40MM PRACT (LINKED)	82,951
B642	CTG 60MM MORTAR HE	14
B643	CTG, 60MM HE M888	98
B647	CTG, 60MM ILLUM M721	10
BINO	BINOCULARS	12
C045	K11, REFURBISH CTG, 81MM PRAC	389
C226	CTG 81MM ILLUM	179
C227	81MM TP W/PD FUZE	172
C256	CTG 81MM HE	2,100
C262	CTG, 90MM CANISTER APER M336 (08)	262
C267	CTG, 90MM HE M71 W/O FUZE (12)	80
C276	CTG 81MM SMK WP	511
C341	CTG, 3 IN 50 CAL BL-P MK29/27/185 FLASHLESS (08)	6
C379	CTG120MM W/MULTIPLEOPTION FUZE	272
C623	CTG 120MM PD FUZE 745	2,408
C624	CTG, 120MM SMK	590
C784	CTG 120MM TP-T	6,883
C785	CTG 120MM TPCSDS-T	11,464
C787	M830 HEAT-MP-T	65
C788	CTG 120MM HE M57 W/FUZEPDM935	76
C791	CTG, 120MM HEAT-MP-T, M830 E1	8
C807	PROJ & PROP CHG, 120MM HEAT-T M469	175
C869	CTG, 81MMHE, M889 W/FUZE	210
C871	CTG, 81MMILLUM M853A1 W/FUZE	59
C875	CTG, 81MMPRAC M879 W/FUZE	40
C876	M303	92
C878	CTG, 81MM HE, M984 W/FUZE MULTI-OPTION	82
C995	LAUNCHER & CARTRI 84MM AT-4	209
CA09	CTG, 120MM PRAC FR M931	100
D505	PROJECTILE 155MM ILLUM	686
D510	PROJ 155M HEAT COPPERHEAD M712	26
D528	PROJ 155MM SMOKE M825	565
D540	CHG, PROP 155MM GB M3 SERIES	194
D544	PROJECTILE 155MM HE M107	8,220
D550	PROJECTILE155MMCHEMICAL M110A1	168
D554	PROJ, 155MM SMK VIO M116	242

DoD Identification Code	Description of Ammunition	Quantity Fired
D579	PROJ 155MM HE M549 (RAP)	36
D582	PROJ, 6 INCH, VT-NF, MK34	18
E969	BOMB, PRACTICE, 25LB, BDU33A/B	36
G878	FUZE HAND GRENADE PRACT M228	7,871
G880	GRENADE HD FRAG M61	60
G881	GRENADE HAND FRAG M67	426
G945	GRENADE HD SMOKE YELLOW	8
G950	GRENADE HD SMOKE RED	4
G955	GRENADE HD SMOKE VIOLET	7
H115	ROCKET, 2.75 IN SMK WP W/WHD M156 (HYDRA-70)	144
H185	ROCKET, POD, REDUCED RANGE PRAC. M28A1 MLRS	76
H972	RKT 2.75" PRACTICE HYDRA 70	176
H974	RKT 2.75" PRACT HYDRA 70	342
H975	RKT 2.75" PRACTICE HYDRA 70	2,351
HX07	ROCKET, 83MM HEAA PRAC (SMAW)	7
J143	RKT MOTOR 5" MK22 MICLIC	12
K143	MINEAP NONBOUNDING M18A1CLAYMO	1,073
K145	MINE, APERS M18A1 W/O FIRING DEVICE	8
K180	MINE AT HEAVY M15	33
K181	MINE AT M21	24
K250	MINE AT HEAVY EMPTY M19	29
K765	GREN RIOT CONTROL AGENT CS	98
K768	GREN RIOT CONTROL AGENT CS-1	6
K867	SMOKE POT FLOATING HC M4A2	15
L306	SIGNAL ILLUM REDSTAR PARACHUTE	1
L307	SIGNAL ILLUM WHITE STAR M159	505
L312	SIGNAL ILLUM WHITE STAR PARA	8
L313	SIGNAL, ILLUM GRND AMBER STAR CLUSTER M22A1	3
L314	SIGNAL ILLUM GREEN STAR	14
L324	SIGNAL, SMK GRND GRN PARA M128A1	2
L495	FLARE SURFACE TRIP	3
L594	SIMULATOR, PROJ GRND BURST M115A2 (04)	22
L598	SIM EXPL BOOBYTRAP FLASH	4
L601	SIM HAND GRENADE	25
L602	SIM FLASH ARTILLERY (HOFFMAN)	402
M008	CTG, IMPULSE M270	62
M023	CHARGE DEMO BLK C4 1 1/4 LB	6,442
M028	DEMO KIT BANGALORE TORPEDO	257
M030	CHARGE DEMO 1/4 LB M1A4	100
M032	CHARGE DEMO TNT 1LB M1A4	34
M038	CHG, DEMO BLOCK M5A1 2 1/2 LB COMP C-3	15
M039	CHARGE DEMO 40LB CRATER	176
M056	CHG, DEMO BLOCK MK36 4 LB COMP H-6	1,000

DoD Identification Code	Description of Ammunition	Quantity Fired
M118	CAP, BLASTING ELEC NO 8 DELAY	301
M130	CAPBLASTING ELEC M6	87
M131	CAPBLASTING NON-ELEC M7	288
M171	CTG, POWDER ACTUATED CAL .22	240
M282	CTG, DELAY MK4 MOD 2	18
M327	COUPLING BASE, FIRING DEVICE W/PRIMER	15
M420	CHARGE DEMO SHAPED 15LB	142
M421	CHARGE DEMO SHAPED 40LB	4
M455	CORD, DET PETN	900
M456	CORD DETONATING REINFORCED	20,537
M670	FUSE BLASTING TIME	2,608
M766	IGNITER TIME BLASTING FUSE PUL	40
M852	SQUIB, ELEC MK13 MOD 0	650
M880	CANISTER, CTG ACTUATED M9	314
M881	CANISTER, CTG ACTUATED M13	1,800
M914	CHARGELINE MINE CLEARING M68A2	4
M918	CTG 40MM TP UNLINKED F/CEV	190
ML45	NON-ELECT BLASTING CAP M11	527
ML47	BLASTING CAP HOLDER M9	1,822
MN02	NON-ELECT BLASTING CAP M12	294
MN03	NON-ELECT BLASTING CAP M13	263
MN06	NON-ELECT BLASTING CAP M14	714
MN08	IGNITER TIME FUZE	1,145
N100	NO DODIC	11
N279	FUZE, MTSQ M518 W/BOOSTER (04)	30
PB96	GM TOW PRACT	12
PB99	TOW PRACTICE	20
PV18	GUIDED MISSILE, SURF ATTACK BGM-71F (TOW28)	27
R120	LASER GLD	8
TOTAL ROUNDS:		6,810,458

3 Problem Formulation

Selection of Assessment Endpoints

An assessment endpoint is an explicit expression of the actual environmental value to be protected (USEPA 1992) at each of the installations. Assessment endpoints typically cannot be directly measured. Therefore, researchers selected measurement endpoints that are measurable biological responses to the contaminants of concern that can be used to make inferences about the assessment endpoint.

The primary assessment endpoint for this risk assessment is the protection and sustainability of selected threatened and endangered species at the installations. The following list identifies the threatened and endangered species of concern at each installation:

Selection of Measurement Endpoints

The USEPA provides a list of recommended considerations when developing measurement endpoints. Criteria for measurement endpoints can include those that allow for and:

- Correspond closely to the assessment endpoint. In this instance the measurement endpoints are representative of, correlated with, and applicable to the assessment endpoint.
- Are specific to the site. Specific threatened and endangered species have been identified for each installation.
- Are specific to the stressor. While other contaminants may influence the measurement endpoints, this research focuses on modeled concentrations of S&Os and MUCs to assess the measurement endpoint. The effects values applied are specific to the contaminants of concern.
- Include an objective measure for judging environmental harm. In ecological risk assessment TRVs, and any other criteria (e.g., sediment, water) specific to the contaminants of concern are independently derived benchmarks.
- Are sensitive for detecting changes. The benchmarks used to judge the measures of effect have a dose-response relationship to the contaminants, indicating sensitivity to changes in concentration or dose.

- Are quantitative. The estimates of body burden and dose are quantitative estimates of exposure.
- Include a correlation between stressor and response. The ecological risk assessment will include an analysis of correlation between levels of exposure to a stressor and levels of response, and will evaluate the strength of that correlation through sensitivity analyses.
- Use standard methods. There are no externally recognized methods for benchmark development in EPA or USACE regulations. Methods suggested in the current toxicological literature were used.

The measurement endpoints associated with the assessment endpoints are as follows:

- Measurement Endpoint: modeled doses of S&Os and MUCs to each receptor (i.e., selected threatened and endangered species).
- Measurement Endpoint: modeled concentrations of S&Os and MUCs in plants/tree leaves that serve as a food base for the selected threatened and endangered species.

Profiles for Receptors of Concern

This section provides brief summaries of biological information for the threatened and endangered species of concern. Table 18* provides the exposure parameters used in the modeling, and Table 19 shows the availability of detailed dietary information for the threatened and endangered species of concern.

Indiana Bat

Taxonomy

Class: Mammalia
Order: Chiroptera
Family: Vespertilionidae
Genus: Myotis
Species: sodalis
Common Names: Indiana Myotis, Social Bat, Kentucky Brown Bat

Description

Physical characteristics of the Indiana bat are provided in Table 18.

* Tables and Figures are grouped at the end of the chapter, beginning on page104.

Status

The Indiana bat was listed as endangered throughout its range in 1967 by the U.S. Fish and Wildlife Service (USFWS). Individual states have listed the Indiana bat as endangered, including: New York, New Jersey Georgia, Florida, Mississippi, North Carolina, South Carolina, and Indiana.

Range

Figure 13 shows the range and priority hibernacula of the Indiana bat.

Life History and Ecology

Migration. The Indiana bat migrates between winter hibernacula and summer roosting habitat. Northern migration occurs in late March to early April from hibernacula to roosting locations, and southern migration occurs in late summer (Evans et al. 1998). Indiana bats will migrate approximately 482 k (300 mi) (Barbour and Davis 1969).

Hibernation. Hibernation lasts from October to late April in caves and abandoned mineshafts. Suitable hibernacula will be between 4° and 8° C (29° to 46° F) and relative humidity from 66 to 95 % (Evans et al. 1998). During hibernation, Indiana bats form large clusters consisting of between 500 and 1000 individuals on the ceilings and walls of the hibernacula. Individuals will spontaneously awaken ever 8 to 15 days to change position among the hibernacula, during which time they will occasionally forage for insects (Evans et al. 1998).

Reproduction. Mating occurs in the first 10 days of October at night on the ceilings of hibernacula (USFWS 1999). Ovulation, fertilization, and implantation are not believed to occur until after hibernation breaks in early spring (Thomson 1982). Females form maternity colonies in suitable roosts, which generally include less than 50 reproductive females. Birthing occurs in June and July when the female will give birth to a single offspring. Juvenile Indiana bats are weaned and become volant within 37 days after birth (Humphrey et al. 1977).

Roosting Habitat. Roosting occurs under the bark of hollow areas in a hardwood bole. Ideal roosting trees are located within floodplain deciduous forests or in upland stands adjacent to riparian or floodplain forests with at least 30 percent canopy cover and permanent water within 0.5 km (Garner and Gardner 1992). Hardwood boles of species such as cottonwood, oak, hickory, and elm are highly suitable roosts. Tagged Indiana bats have been found to return to the same roost trees over successive years (Humphrey et al. 1977, Garner and Gardner 1992).

Foraging. Indiana bats are primarily insectivorous, feeding on moths (Lepidoptera), beetles (Coleoptera), flies and midges (Diptera) in the forest canopy (Evans et al. 1998). Ideal foraging areas are closed canopy riparian forests. Foraging has been observed in the canopy of riparian forest, around upland slopes and ridges, in early successions openings in the forest, over impounded water, and in forest /agricultural transition zones (Evans et al. 1998). Streams without riparian vegetation are not suitable foraging areas (Cope et al. 1978). Foraging ranges for females is dependant of reproductive state. During lactation, foraging range averaged 94.2 ha, and post lactation foraging range averaged 212.7 ha (Evans et al. 1998). Juveniles have an average foraging range of 28.5 ha (Evans et al. 1998). Males will travel up to 1.5 km from roosts to foraging areas (Evans et al. 1998).

Predators. Known predators include mink (*Mustella viso*), screech owl (*Otus asio*), and black rat snake (*Elaphe obseleta obseleta*) (Evans et al. 1998).

Gray Bat

Taxonomy

Class:	Mammalia
Order:	Chiroptera
Family:	Vespertilionidae
Genus:	Myotis
Species:	grisescens

Description

Physical characteristics of the gray bat are provided in Table 18.

Status

The gray bat was listed as endangered throughout its range in 1967. Individual states have listed the gray bat as endangered, including: Arkansas, Florida, Georgia, Mississippi, Tennessee, Indiana, Illinois, Kentucky, Missouri, and North Carolina.

Range

Figure 14 shows the range of the gray bat.

Life History and Ecology

Migration. The gray bat lives in caves year round, but migrates between summer roosting caves and winter hibernacula (Gore 1992). Adult females break hibernation and begin northern migration first in late March to early April, followed by males and juveniles in mid March to mid April (Mitchell 1998). Southern migration to hibernacula occurs for females in early September, followed by males and juveniles in mid October (Tuttle 1976). Migration distances range from 17 to 500 km (11 to 310 miles) in large flocks that will stop to rest in suitable caves en route (Mitchell 1998).

Hibernation. Suitable hibernation caves are deep and vertical and average 10º C (50 ºF) (Mitchell 1998). Females enter hibernation after mating, while males will remain active for several weeks after mating. Most gray bats are in hibernation by November. Hibernation occurs on the ceilings of large rooms within the caves. Individuals form large clusters of several thousand bats that will be several layers deep (Gore 1992). Gray bats will return to the same hibernacula over successive years (Tuttle 1976).

Reproduction. Mating occurs when males arrive at the winter hibernacula, but ovulation and fertilization does not occur until after females have broken hibernation the following spring (Mitchell 1998). After migration, females congregate in maternity caves, while males and yearlings congregate in separate sections of the roosting cave. The maternity section is located in the warmest areas of the roosting cave (Tuttle 1976). The gray bat has a gestation period of 60 to 70 days (Saugey 1978), after which females will give birth to one offspring. The offspring cling to the females for approximately 1 week and then remain in the nursery cave while the female forages (Burt and Grossenheider 1976). Young become volant after 4 weeks and are weaned shortly after, usually in late June to mid July (Mitchell 1998). Gray bats become sexually mature at age 2, and have a potential longevity of 17 years (Mitchell 1998).

Roosting Habitat. Roosting caves range from 14º to 25º C (57 ºF to 77 ºF) and are similar in shape to hibernation caves (Mitchell 1998). During maternity, females live in separate cave sections from males and juveniles. After the young are fledged, bats of all sexes and ages will share the same cave sections. Ideal roosts will be located within 1 km of a major water body, and very few roosts will be found past 4 km from major water bodies (Tuttle 1976). Forested areas surrounding the cave entrance and/or on routes to foraging areas are advantageous for gray bats. Juveniles will use forested areas close to the cave for foraging. Adults will use the canopy as cover from predators during movement to and from foraging areas (Mitchell 1998).

Foraging. Gray bats feed exclusively on insects and will consume 55 families of insects comprising 15 orders, including flies (Diptera), beetles (Coleoptera), caddisflies (Trichoptera), moths (Lepidoptera), wasps (Hymenoptera), stoneflies (Plecoptera), leafhoppers (Homoptera), and mayflies (Ephemeroptera) as the primary food sources (Mitchell 1998). Gray bats emerge from caves in early evening and follow direct overland routes to foraging areas over water bodies and associated wetland areas. Foraging occurs between 2 and 5 m of the water surface (Mitchell 1998). In early evening, gray bats feed in slowly traveling groups while insect abundance is at a peak, after which the bats will become territorial. Foraging areas will be occupied by 1 to 15 individuals. Foraging areas are located between 2 to 28 km from roosting sites, and bats will return to successful foraging areas each year (Mitchell 1998).

Predators. The screech owl is primary predator of the gray bat (Mitchell, 1998).

Gopher Tortoise

Taxonomy

Class: Reptilia
Order: Testudines
Family: Testudinidae
Genus: Gopherus
Species: polyphemus
Common Names: Gopher, Hoover Chicken

Description

Physical characteristics of the gopher tortoise are provided in Table 18.

Status

The Western population (i.e., west of the Tombigby and Mobile Rivers in Alabama) of the gopher tortoise was listed as threatened in 1987. The Eastern population is not listed as threatened or endangered, but is considered a species of concern.

Range

Figure 15 shows the range of the gopher tortoise.

Life History and Ecology

General. The gopher tortoise is a terrestrial turtle that requires habitat with soft soils for burrowing, herbaceous vegetation for foraging, and sunny areas for nesting

and thermoregulation (Wilson et al. 1997). Five age classes of the tortoise have been identified: eggs, hatchlings (up to 1 year), juveniles (1 to 4 years), subadults (5 to 15 years), and adults (16+ years) (Wilson 1991).

Burrowing. The gopher tortoise relies primarily on burrowing for survival. Burrows are generally straight and unbranched measuring 5 meters in length, sloping downward near a single entrance and leveling off at an inner chamber large enough to allow the tortoise to turn around (Wilson et al. 1997). Burrows provide shelter from predators, fire, and extreme temperatures. Gopher tortoises prefer well-drained sandy soils for burrowing but will dig shorter burrows in more clayey soils (Wilson et al. 1997). A large number of species are dependent on gopher tortoise burrows for refuge, including over 60 vertebrate and 300 invertebrate species (Jackson and Milstrey 1989).

Reproduction and Development. Sexual maturity is dependant on carapace length rather than age in the gopher tortoise. Females are sexually mature at carapace length of 22.5 to 26.5 cm (8.86 to 10.43 in.), typically between ages 10 and 21 yrs (Ernst et al. 1994).

Mating occurs during fall and spring, with peak mating occurring in May and June (Wilson et al. 1997). Dominant males will mate with several females after performing a courtship behavior of bobbing his head and biting the female's forelegs, head, and carapace anterior (Wilson et al. 1997). Ovulation occurs in late spring and is complete by late May (Iverson 1980). The female will dig a nest in a sunny area, which can be in the spoil mounds by the entrance to her burrow or several feet away from the burrow (Wilson et al. 1997). Nesting occurs from late April to mid July with a peak nesting period between May and mid June (Wilson et al. 1997). Nests are approximately 12.6 cm deep from the surface to the uppermost egg and will contain a single clutch of 1 to 25 eggs (Wilson et al. 1997). Clutch size increases with the female's carapace size and will most often contain 4 to 9 eggs (Wilson et al. 1997). Eggs incubate between 80 and 100 days before hatching, which occurs from late August through early October (Wilson et al. 1997). Hatchlings are 4 to 5 cm long at emergence from the nest and will dig their own burrows within a few meters of the nesting area (Wilson et al. 1997).

Gopher tortoises exhibit no parental care for eggs or juveniles, leaving the young open to predation. Raccoon, skunk, armadillo, fox, opossum, snakes, and fire ants (*Solenopsis invicta*) are predators of gopher tortoise egg nests and juveniles, which have soft shells up to age 5 to 7 yrs (Wilson et al. 1997).

Foraging. Gopher tortoises are primarily herbivorous; feeding of grasses and herbaceous plants, but will also consumes fruits, feces, and carrion if encountered during

foraging (Wilson et al. 1997). Water is consumed when available, usually when pooled at the mouth of the burrow, and rocks will be consumed to provide minerals (Wilson et al. 1997). A gopher tortoise has a well-defined home range used for foraging, which will increase with age when necessary but is more dependant, inversely correlated, with food resource abundance. The estimated range of foraging activity size is as follows: adult males between 0.45 to 1.27 ha (1.11 to 3.14 acres), adult females between 0.08 to 0.56 ha (0.2 to 1.38 acres), and juveniles between 0.01 to 0.36 ha (Wilson et al. 1997). Gopher tortoise foraging activity is both unimodal and bimodal depending on geographic location, age, and temperature. Bimodal foraging generally occurs between 1000 to 1200 hrs and again at 1600 to 1800 hrs (Douglas and Layne 1978). Unimodal foraging generally occurs between 1000 and 1400 hrs (Douglas and Layne 1978). There is no evidence of nocturnal activity. Gopher tortoises are most active during spring and summer months.

Predation. Adult gopher tortoises have few predators due to their size and structure. Eggs and juveniles are heavily preyed upon, as discussed above.

Desert Tortoise

Taxonomy

Class:	Reptilia
Order:	Chelonia
Family:	Testudinidae
Genus:	Gopherus
Species:	agassizii

Description

Physical characteristics of the desert tortoise are provided in Table 18.

Status

The desert tortoise is listed as threatened except for populations in Arizona south and east of the Colorado River and in Mexico.

Range

Figure 16 shows the range of the desert tortoise.

The desert tortoise occurs in the Mohave and Sonoran deserts in southwestern Utah, southern Nevada, southeastern California, western Arizona, and Mexico.

Life History and Ecology

General. Three distinct subpopulations of the desert tortoise have been identified by home range: the Mohave Desert population, the Sonoran Desert population, and the tropical Sonora and Sinaloa population of northwestern Mexico (Lawler 2003). Habitat of the desert tortoise ranges from sandy flats to rocky foothills and includes alluvial fans, washes, and canyons with suitable soils for den construction from near sea level to 3500 ft above sea level (Lawler 2003). Home range depends on food availability, age, and sex of the tortoise.

Burrowing. Burrowing habits of the desert tortoise vary between the subpopulations. The Mohave Desert population constructs the most extensive burrows, often digging up to 35 ft long half-moon shaped entrances tall enough to allow for easy entrance (Lawler 2003). Burrows are shared between approximately 5 individuals and are dug at the base of rocks or bushes on sloped terrain. Most burrows have a relative humidity of 40 percent, which aids in water conservation (Lawler 2003). The southern populations, including the Sonoran and tropical Sonoran/Sinaloa populations, burrow little if at all, depending on terrain. If suitable soils are present, the tortoise will dig burrows up to 6 ft deep on the slopes of rocky foothills (Lawler 2003). More commonly, the tortoise will utilize existing refuges such as under rocks or another animal's burrow.

Foraging. The desert tortoise consumes a variety of grasses, perennials, annual wildflowers, cactus fruits, and other herbaceous plants. Rocks and soils are also ingested, possibly as source of nutrients or as gastroliths to aid digestion (Lawler 2003). The tortoise will vary foraging activities around ambient temperature and season to avoid the hottest and driest periods of the day.

Water Conservation. The desert tortoise has developed several habits and adaptations to successfully survive in arid climates. The primary means of water intake is through consumed vegetation (Lawler 2003). The tortoise has also been observed digging small pits close to their burrows to trap rainwater, often just before a rainfall event (Burg and Roy 2003). The desert tortoise is able to precipitate and expel solid urates from a bladder that can hold approximately forty percent their body weight (Lawler 2003). Northern populations will sometimes go dormant during the hottest and direst parts of summer to conserve water (Lawler 2003).

Reproduction. In the desert tortoise sexual maturity is dependant on carapace length rather than age. Sexual maturity is reached between 12-20 yrs (Burg and Roy 2003). Males court females by extensive head bobbing and biting the legs, head, and anterior carapace of the females. Mating occurs from early spring to early fall with the greatest frequency in late summer (Lawler 2003). Females can

store sperm in their cloacae for later fertilization if environmental conditions are not suitable for egg laying. Nests are dug within burrows or close to the burrow entrance. Females will urinate on the nests before and after egg laying and again after the nests have been covered, either to camouflage the nest's scent from predators or to prevent egg desiccation (Lawler 2003). Nesting primarily occurs during May. Females lay clutches of 1 to 14 eggs and will defend nests from predators during the 90- to 135-day incubation period (Lawler 2003). Southern tortoise populations may lay a second clutch in June of the same year. Hatchlings have high mortality rates due to predation and environmental conditions.

Hibernation. Northern populations hibernate during winters. Southern population may not hibernate due to mild winters (Lawler 2003).

Red-cockaded Woodpecker

Taxonomy

Class:	Aves
Order:	Piciformes
Family:	Picidae
Genus:	Picoides
Species:	borealis

Description

Physical characteristics of the red-cockaded woodpecker are provided in Table 18.

Status

The red-cockaded woodpecker is listed as endangered in its entire range.

Range

Figure 17 shows the range of the red-cockaded woodpecker.

Life History and Ecology

Habitat. The red-cockaded woodpecker exclusively inhabits mature pine woodlands with a preference for using longleaf pine (*Pinus palustris*) for roosting and nesting (USFWS 2003). Optimum habitat is characterized as broad savanna with a scattered overstory of large pines and dense groundcover containing grasses, forbs, and shrubs (Jackson 1994).

Social Structure. Red-cockaded woodpeckers are non-migratory, cooperative birds that form small groups consisting of one breeding pair and up to four “helper” individuals. Helpers are often juvenile males from the previous breeding season that assist in egg incubation, feeding nestlings and fledglings, and defending territories (Jackson 1994). Each member of a group has an individual roost cavity in a cluster of 1 to 20 cavity trees within a 3- to 60-acre area (USFWS 2003). The group will defend a well-defined home range of approximately 15 to 225 ha (average 70 ha) by singing, drumming with their beaks, and males raising their red cockades on each side of the head (USFWS 2003). Both males and females will display threat behavior during breeding season if there is an intruder in the nesting area. Red-cockaded woodpecker individuals will disperse from the group to join another group primarily after fledging but also due to mate loss or an apparent avoidance of inbreeding within the group. Young females will most often disperse. Fledgling males will disperse the farthest on average (5.1 km), and helper males will disperse the shortest distance on average (1.8 km) (USFWS 2003).

Roost/Nest Cavities. While red-cockaded woodpeckers will excavate new roost and nest cavities, they rely primarily on cavities made available due to dispersion. The dispersal of individuals within each group regularly frees cavities for individuals from other groups to occupy. Cavity excavation can take several months to years (USFWS 2003). Cavities are excavated at an upward angle through the sapwood of a cavity tree to allow for pitch drainage and to prevent rainwater from flooding. When excavation has passed through the sapwood into the heartwood, the cavity will turn downward to a gourd-shaped chamber approximately 15 to 25 cm deep by 2 to 13 cm wide (USFWS 2003). The average distance between cavity trees is between 58 and 104 m (USFWS 2003).

Reproduction. Mated pairs of the red-cockaded woodpecker are monogamous. Copulation typically occurs between March and May (USFWS 2003). Egg lying occurs in April through early May with a single female laying between 2 and 5 eggs (3 to 4 average) (USFWS 2003). The nest is most often located in the breeding male’s nest cavity. Incubation lasts 10 to 12 days and nestlings will remain in the nest for 26 to 29 days (USFWS 2003). Nesting activity is usually finished completely by early July. Fledglings are able to follow adults on extended foraging trips 3 to 5 days after fledging, but may still beg and receive food from adults up to several months after fledging (USFWS 2003). Hatchling mortality can be relatively high due to predation, primarily by snakes.

Foraging. Red-cockaded woodpeckers are primarily insectivorous but will supplement with fruits and berries. Wood boring insects can comprise a large part of the woodpecker’s diet, which will also include beetles, ants, roaches, caterpillars, and spiders (USFWS 2003). Most foraging occurs on mature pine trees or in open pine

habitats. Food is located by sight and by probing cavities with the woodpecker's long tongue (USFWS 2003). Individuals will ascend trees in a spiral pattern while prying up pieces of bark with the claws and beak to expose prey. The red-cockaded woodpecker will occasionally catch airborne insects while in flight.

Predation. Most predation of red-cockaded woodpeckers occurs on nestling and fledglings. Accipiter hawks will prey on adults (USFWS 2003).

Black-capped Vireo

Taxonomy

Class:	Aves
Order:	Passeriformes
Family:	Vireonidae
Genus:	Vireo
Species:	atricapilla

Description

Physical characteristics of the black-capped vireo are provided in Table 18.

Status

The U.S. Fish and Wildlife Service listed the black-capped vireo as endangered in 1987.

Range

Figure 18 shows the range of the black-capped vireo.

Life History and Ecology

Habitat. The black-capped vireo migrates between winter grounds on the western coast of Mexico and breeding grounds of northeast Mexico, central Texas, and some sparse remaining habitat of southwest Oklahoma (Guilfoyle 2002). Optimal breeding grounds are low thickets in scrub oak-juniper woodlands in arid hilly areas near water (Drake 2000). Territory size ranges between 1 and 10 acres with most being 2 to 4 acres (Damude 2003). Nests are built on forked twigs approximately 2 to 6 ft above the ground (Guilfoyle 2002).

Migration. The black-capped vireo arrives in its breeding ground in early March, and arrives at its winter grounds by late September. Adult males arrive at the breeding ground before and depart after females and young males (Guilfoyle 2002).

Reproduction. The breeding period begins mid-April and ends by early August (Guilfoyle 2002). Monogamous mating pairs are formed when the females arrive at the breeding grounds. Females then begin to build the nests with some help from the males. Nests are compact and cup-like, consisting of leaves, coarse grasses, tree bark, and spider cocoons bound with plant fibers, spider webs, and caterpillar wool (Drake 2000). Nest construction takes 6 to 9 days (Drake 2000). Females lay clutches of 3 to 5 eggs, which are incubated by both males and females for 14 to 17 days (Drake 2000). Males bring approximately 75 percent of the food for hatchlings, which fledge 10 to 12 days after hatching (Drake 2000). Black-capped vireo chicks have a low success ratio of 1 to 2 chicks per pair (Drake 2000). This low success ratio is highly due to nest parasitism by the brown-headed cowbird, which removes black-capped vireo eggs and lays their own to be hatched and raised by the vireos (Drake 2000). The brown-headed cowbird eggs hatch earlier than the black-capped vireo eggs, giving them an advantage (Guilfoyle 2002).

Foraging. The black-capped vireo primarily eats insects such as caterpillars and beetles. Young supplement their diet with spiders, while adults supplement with fruits and berries (Guilfoyle 2002). Individuals hang upside down from branches while foraging among deciduous and broad-leafed trees and shrubs (Drake 2000).

Predation. Predators include jays, squirrels, skunks, raccoons, rat snakes, and fire ants.

Golden-cheeked Warbler

Taxonomy

Class:	Aves
Order:	Passeriformes
Family:	Parulidae
Genus:	Dendroica
Species:	chrysoparia

Description

Physical characteristics of the golden-cheeked warbler are provided in Table 18.

Status

The U.S. Fish and Wildlife Service listed the golden-cheeked warbler as endangered in 1990.

Range

Figure 19 shows the range of the golden-cheeked warbler.

Life History and Ecology

Habitat. The golden-cheeked warbler migrates between breeding grounds located exclusively in central Texas to wintering grounds in the highlands of central Mexico and south thru Nicaragua (Damude 2003). Breeding grounds are restricted to mature Ashe juniper stands mixed with other deciduous trees, oak in particular (Guilfoyle 2002). Water must be located close to the nests for drinking and bathing (Damude 2003).

Migration. Golden-cheeked warblers arrive at breeding grounds from mid March and depart toward wintering areas in mid-July (Guilfoyle 2002).

Reproduction. Monogamous mating pairs are formed shortly after arrival at breeding grounds. Females build the nests in branch forks approximately 15 ft above ground in 4 to 6 days (Guilfoyle 2002). Bark from 20-to 30-yr old juniper trees is needed for nest construction (Damude 2003). Females lay clutches of 3 to 4 eggs and are solely responsible for incubation (Guilfoyle 2002). Males will feed the females during the 12-day incubation period (Guilfoyle 2002). Both males and females will feed the hatchlings. Fledging occurs 9 to 12 days after hatching, and fledglings will rely on adults to feed them for at least 4 weeks after leaving the nest (Guilfoyle, 2002). Golden-cheeked warbler nests are targeted by the parasitic nesting brown-headed cowbird, which removes warbler eggs and lays their own to be hatched and raised by the warblers. The brown-headed cowbird eggs hatch earlier than the golden-cheeked warbler eggs, giving them an advantage (Guilfoyle 2002).

Foraging. Golden-cheeked warblers are entirely insectivorous, foraging on caterpillars, flies, and spiders among the foliage of Ashe junipers and a variety of oaks (Stout 1999).

Predation. Predators of the golden-cheeked warbler include rat snakes and coach whips, and opportunistic opossum, squirrel, and cats (Guilfoyle, 2002).

Conceptual Model

Each installation has essentially the same conceptual model of exposure for each of the selected threatened and endangered species. These are shown in Figure 20 for S&Os and Figure 21 for the MUCs.

S&Os are typically and most commonly released during fog oil training exercises or maneuvers. They may be administered via vehicle-equipped generators or from handheld devices. S&O usage results in a cloud comprised of vapor and particulate that may undergo subsequent dry and wet deposition onto soil, plant surfaces, other prey items, and water surfaces. Munition usage, by contrast, is from direct-fired artillery and handheld devices (i.e., rifles, pistols, etc.) When munitions fire correctly, there is very little chemical residue remaining in the environment. However, particularly for the larger and or "self-contained" munition types (e.g., grenades, mortars, artillery, and other munitions with high explosive and other projectile internal contents), there is a known "dud" rate or misfire rate. This results in the potential for chemicals to enter the environment into the soil where the projectile has landed. Once in the soil, the MUCs may undergo subsequent chemical transformation, subsurface transport to groundwater, or can be taken up by plants and other organisms depending on the chemical and physical properties of each individual constituent.

Depending on the prey items favored by each of the threatened and endangered species, they may be exposed to S&Os and MUCs via ingestion of different prey items. The exposure pathways (described in Figures 20 and 21) for this screening level assessment are considered as follows:

Smoke and obscurant exposure pathways

Air → deposition onto plants and leaves → leaf and plant ingestion by terrestrial insects, caterpillars, etc. → ingestion of prey items by higher vertebrates (e.g., birds and bats).

Air → deposition onto plants → leaf ingestion by tortoise, and other herbivores.

Air → deposition onto water → settling of particulate to sediment → sediment ingestion by emergent aquatic insects → ingestion of aquatic insects by higher vertebrates (e.g., birds and bats).

Munitions related chemical exposure pathways

Soil → uptake into trees and tree foliage → leaf ingestion by terrestrial insects, caterpillars, etc. → ingestion of prey items by higher vertebrates (e.g., birds and bats).

Soil → uptake into plants → plant and incidental soil ingestion by tortoise.

A complete exposure pathway that may be important given the specific physical and chemical properties of the individual munitions is:

Soil → runoff into surface water → settling of particulates to sediment → ingestion by emergent aquatic insects → ingest of aquatic insects by bats and birds.

However, this path could not be quantified even at a screening level due to the complexity of the modeling (e.g., universal soil loss equation, which requires detailed information on topography, soil type, vegetation type, etc.) and the number of assumptions required. This screening level assessment assumes that all of the constituents in the munitions are available for uptake by plants and the potential runoff to water and aquatic life forms is not quantified.

Table 18. Exposure parameters for the TES of concern.

	Life Span			Body Weight			Body Length			Wingspread		
Species	**Range**	**Mean**	**Source**	**Range**	**Mean**	**Source**	**Range**	**Mean**	**Source**	**Range**	**Mean**	**Source**
Indiana Bat (*Myotis sodalis*)	13 - 20 years		Evans et al., 1998	7 - 9 g	8 g	Evans et al., 1998	7.5 - 10 cm	8.75 cm	Evans et al., 1998	24 - 27 cm	25.5 cm	Evans et al., 1998
Gray Bat (*Myotis grisescens*)	up to 17 years		Mitchell, 1998	8 - 16 g	10.5 g	Mitchell, 1998		8.7 cm	Mitchell, 1998	27.5 - 30 cm	28.8 cm	Mitchell, 1998
Gopher Tortoise (*Gopherus polyphemus*)	40 - 60 years		Germano, 1992	2064 - 4911 g (adults ages 15 - 31+)	3500 g	Landers et al., 1982	15 - 37 cm (carapace)	25 cm (carapace)	Wilson and Mushinsky, 1997	NA	NA	
Desert Tortoise (*Gopherus agassizii*)	32 - 52 years		Germano, 1992	1030 - 3021 g	1995 g	Cal/ECOTOX	23 - 38 cm (carapace)		Burg and Roy, 2003	NA	NA	
Red-Cockaded Woodpecker (*Picoides borealis*)	up to 16 years		USFWS, 2003	40 - 55 g	47.5 g	USFWS, 2003	20 - 23 cm		USFWS, 2003	35 - 38 cm		NatureServe, 2003
Black-Capped Vireo (*Vireo atricapillus*)	5 - 6 years		USFWS, 1991	9 - 10 g	10 g	USFWS, 1991	11 - 12 cm		Damude, 2003		16.5 cm	Drake, 2003
Golden-Cheeked Warbler (*Dendroica chrysoparia*)					9.4 (male), 10.2 (female)	USFWS, 1992	11 - 13 cm		Damude, 2003		20.3 cm	Damude, 2003

Table 18 Continued.

Species	Inhalation Rate		Surface Area		Ingestion Rate						
	Mean	Source	Mean	Source	Range	Mean	g dw /day	Food Type	Source	Mean (g Wet Weight/day[4]	Mean (kg Wet Weight/day[4]
Indiana Bat (*Myotis sodalis*)	0.00034 m3/day	BHE, 2001	0.022 m2	BHE, 2001		0.0025 kg/day	2.5	Insect	BHE, 2001	4.25	0.00425
Gray Bat (*Myotis grisescens*)	0.00034 m3/day	BHE, 2001	0.026 m2	BHE, 2001		0.0025 Kg/day	2.5	Insect	BHE, 2001	4.25	0.00425
Gopher Tortoise (*Gopherus polyphemus*)						11.6 g dry matter/day	11.6	Plant	Nagy, 2001	20.90	0.02090
Desert Tortoise (*Gopherus agassizii*)					0 - 15.6 g dry matter/ Kg/d	4.52 g dry matter/Kg/d	4.52	Plant	Cal/ECOTOX	8.14	0.00814
Red-Cockaded Woodpecker (*Picoides borealis*)	0.045 L/min [1]	Driver et al., 2002				9.00 g dry matter/day [3]	9	Insect	USEPA, 1993	15.30	0.01530
Black-Capped Vireo (*Vireo atricapillus*)						2.82 g dry matter/day [2]	2.82	Insect	USEPA, 1993	4.79	0.00479
Golden-Cheeked Warbler (*Dendroica chrysoparia*)						2.82 g dry matter/day [2]	2.82	Insect	USEPA, 1993	4.79	0.00479

Notes: 1 Calculated using Red-winged Blackbird as surrogate species.
2 Calculated using equation 3-4 IN USEPA Wildlife Exposure Factors Handbook. Vol. I. December 1993. EPA 600/R-93/187a.
3 Calculated using equation 3-3 IN USEPA Wildlife Exposure Factors Handbook. Vol. I. December 1993. EPA 600/R-93/187a.
4 Wet weight ingestion rate calculated assuming 70% water for insect prey and 80% water for plants.

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Table 19. Detailed dietary composition for the TES of concern.

Golden-Cheeked Warbler				
Source	**Diet Component**	**Common Name**	**Food Type**	**Percent of Diet**
Pulich, 1976 IN: USFWS, 1992	Beetles		Insect	32
	Caterpillars		Insect	17
	Homoptera	Winged insects	Insect	17
	Hemiptera	Winged insects	Insect	13
	Spiders	Spiders	Insect	11
Kroll, 1980 IN: USFWS, 1992	Lepidopteran larvae	Moths	Insect	54
	Orthoptera	Grasshoppers, crickets	Insect	13
Black-Capped Vireo				
Source	**Diet Component**	**Common Name**	**Food Type**	**Percent of Diet**
Graber, 1961	Wintering Months			
	Vegetable Matter		Plant	38
	Spiders		Insect	2
	Odonata	Dragonflies, damselflies	Insect	3
	Hemiptera	Winged insects	Insect	7
	Coleoptera	Beetles	Insect	5
	Lepidoptera	Moth	Insect	43
	Diptera	True flies	Insect	2
	Nesting Months			
	Vegetable Matter		Plant	1
	Spiders		Insect	4
	Centipedes		Insect	6
	Orthoptera	Grasshoppers, crickets	Insect	3
	Hemiptera	Winged insects	Insect	1
	Homoptera	Winged insects	Insect	3
	Coleoptera	Beetles	Insect	28
	Lepidoptera	Moth	Insect	53
	Diptera	True flies	Insect	1
Gopher Tortoise				
Source	**Diet Component**	**Common Name**	**Food Type**	**Percent of Diet**
Macdonald and Mushinsky, 1988	Plant Family			
	Asteraceae	Daisies, dandelion, thistles	Plant	8
	Bromeliaceae	Bromiliads	Plant	5.1
	Cyperaceae	Sedges	Plant	3
	Ericaceae	Rhododendron, heather, blueberry	Plant	1.8
	Euphorbiaceae	Shrubs	Plant	5.5
	Fabaceae	Herbs	Plant	7.3
	Fagaceae	Chestnut, oak	Plant	9.1

	Iridaceae	Iris	Plant	1.1
	Pinaceae	Fir, cedar, spruce, pine	Plant	9.7
	Poaceae	Grasses	Plant	31.3
	Polygonaceae	Herbs and shrubs	Plant	3.9
	Rosaceae	Berries, wild rose	Plant	1.5
	Rubiaceae	Small trees, shrubs	Plant	4.8
	Scrophulariaceae	Flowering herbs	Plant	1.5
Garner and Landers, 1981	April - mid May			
	Broad-Leaved Grasses		Plant	90
	Legumes		Plant	5
	Minor Plants		Plant	3
	Dead Pine Leaves		Plant	1
	mid May - June			
	Broad-Leaved Grasses		Plant	48
	Wiregrass		Plant	1
	Legumes		Plant	14
	Morning Glory	Shrub	Plant	16
	Dyschoriste	Flowering herb	Plant	6
	Poor Joe	Shrub	Plant	3
	Fleshy Fruit		Plant	1
	Minor Plants		Plant	8
	Dead Pine Leaves		Plant	3
	July - Sep			
	Broad-Leaved Grasses		Plant	66
	Wiregrass		Plant	1
	Legumes		Plant	5
	Morning Glory	Shrub	Plant	1
	Dyschoriste	Flowering herb	Plant	5
	Poor Joe	Shrub	Plant	3
	Fleshy Fruit		Plant	5
	Florida Pussley	Shrub	Plant	7
	Minor Plants		Plant	4
	Dead Pine Leaves		Plant	1
	Oct - Dec			
	Broad-Leaved Grasses		Plant	86
	Wiregrass		Plant	1
	Poor Joe	Shrub	Plant	9
	Pawpaw	Fruiting tree	Plant	1
	Dead Pine Leaves		Plant	1

Indiana Bat				
Source	**Diet Component**	**Common Name**	**Food Type**	**Percent of Diet**
Brack and LaVal, 1985	Lepidoptera	Moth	Insect	83
	Coleoptera	Beetles	Insect	8
	Diptera	True flies	Insect	1
	Trichoptera	Caddisflies	Insect	4
	Plecoptera	Stoneflies	Insect	1
	Homoptera	Winged insects	Insect	2
	Other		Insect	1
Whitaker, 1972	Hymenoptera	Ants, wasps, bees	Insect	50
	Homoptera	Winged insects	Insect	19
	Coleoptera	Beetles	Insect	24
Desert Tortoise				
Source	**Diet Component**	**Common Name**		**Percent of Diet**
Nagy and Medica, 1986	*Langloisia setosissima*	Flowering herb	Plant	39.5
	Camissonia munzii	Flowering herb	Plant	34
	Oryzopsis hymenoides	Ricegrass	Plant	14.5
	Bromus rubens	Grass	Plant	11.5
	Other		Plant	0.5
Hansen et al., 1976	Threeawn	Grass	Plant	13
	Globemallow	Flowering shrub	Plant	9
	Slim tridens	Grass	Plant	23
	Foxtail brome	Grass	Plant	28
	Red grama	Grass	Plant	2
	Sedge	Grass	Plant	1
	Bush muhly	Grass	Plant	6
	Slender janusia	Shrub	Plant	4
	Redstem filaree	Herb	Plant	8
	Common winterfat	Sage	Plant	2
	Vetch	Flowering herb	Plant	1
	Other		Plant	2
Gray Bat				
Source	**Diet Component**	**Common Name**	**Food Type**	**Percent of Diet**
Best et al., 1997	Lepidoptera	Moths	Insect	36
	Diptera	True flies	Insect	26
	Coleoptera	Beetles	Insect	11
	Insecta	Insects	Insect	8
	Unknown		Insect	7
	Trichoptera	Caddisflies	Insect	5
	Hemiptera	Winged insects	Insect	2
	Homoptera	Winged insects	Insect	2
	Hymenoptera	Ants, wasps, bees	Insect	2

Indiana Bat				
Source	Diet Component	Common Name	Food Type	Percent of Diet
	Ephemeroptera	Mayflies	Insect	1
	Araneae	Spiders	Insect	1
	Other		Insect	1

Red-Cockaded Woodpecker				
Source	Diet Component	Common Name	Food Type	Percent of Diet
Hanula and Franzreb, 1995	Diet fed to nestlings			
	Wood Roach		Insect	69
	Wood Borer Beetle larva		Insect	5
	Moth larva		Insect	5
	Spider		Insect	4
	Ant		Insect	3
	Longhorned grasshopper		Insect	3
	Centipede		Insect	3
	Insect larva		Insect	5
	Beetle larva		Insect	1
	Moth or butterfly larva		Insect	1
Hess and James, 1998	Adults			
	Ants (larvae, pupae, adults)		Insect	58
	Beetles (larvae, adults)		Insect	7
	Unidentified larvae		Insect	3
	Hemiptera	Winged insects	Insect	2
	Spiders		Insect	2
	Centipedes		Insect	1
	Carpenter bees		Insect	0
	Roaches		Insect	1
	Lepidoptera	Moth	Insect	0
	Tabanid flies		Insect	0
	Miscellaneous		Insect	1
	Unknown		Insect	2
	Fruit and seeds		Plant	16
	Wood		Plant	9
	Nestlings			
	Ants (larvae, pupae, adults)		Insect	15
	Beetles (larvae, adults)		Insect	14
	Unidentified larvae		Insect	3
	Hemiptera	Winged insects	Insect	2
	Spiders		Insect	15
	Centipedes		Insect	12
	Carpenter bees		Insect	5
	Roaches		Insect	3
	Lepidoptera	Moth	Insect	2
	Tabanid flies		Insect	2

Indiana Bat				
Source	**Diet Component**	**Common Name**	**Food Type**	**Percent of Diet**
	Miscellaneous		Insect	3
	Unknown		Insect	5
	Fruit and seeds		Plant	1
	Wood		Plant	18
Hanula et al., 2000	Diet fed to nestlings			
	Wood Roach		Insect	51
	Caterpillar		Insect	8
	Spider		Insect	7
	Wood Borer larvae		Insect	4
	Beetle (larvae, pupae, adults)		Insect	5
	Ant (larvae, adults)		Insect	4
	Blueberry		Plant	4
	Centipede		Insect	4
	Insect (larvae, adults)		Insect	9
	Hymenoptera (larvae, adults)	Ants, wasps, bees	Insect	2
	Lepidoptera pupae	Moth	Insect	1
	Sawfly larvae		Insect	1
	Other		Insect	1

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Figure 13. Species distribution of the Indiana bat.

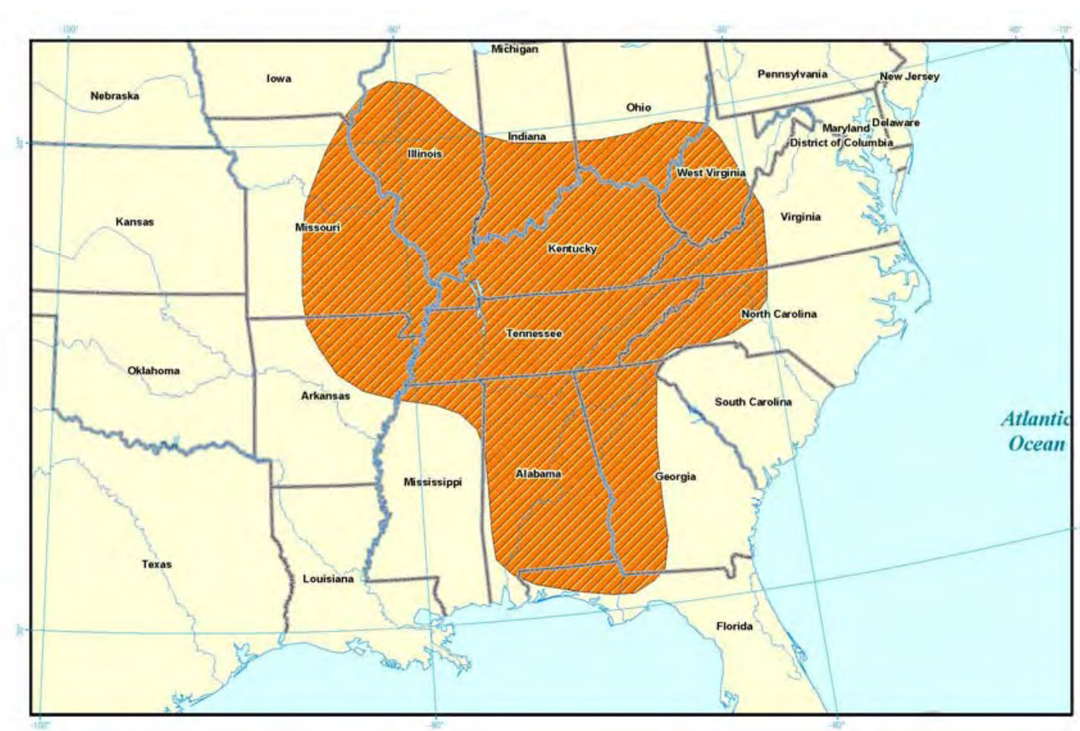

Figure 14. Species distribution of the gray bat.

Figure 15. Approximate species distribution of the gopher tortoise.

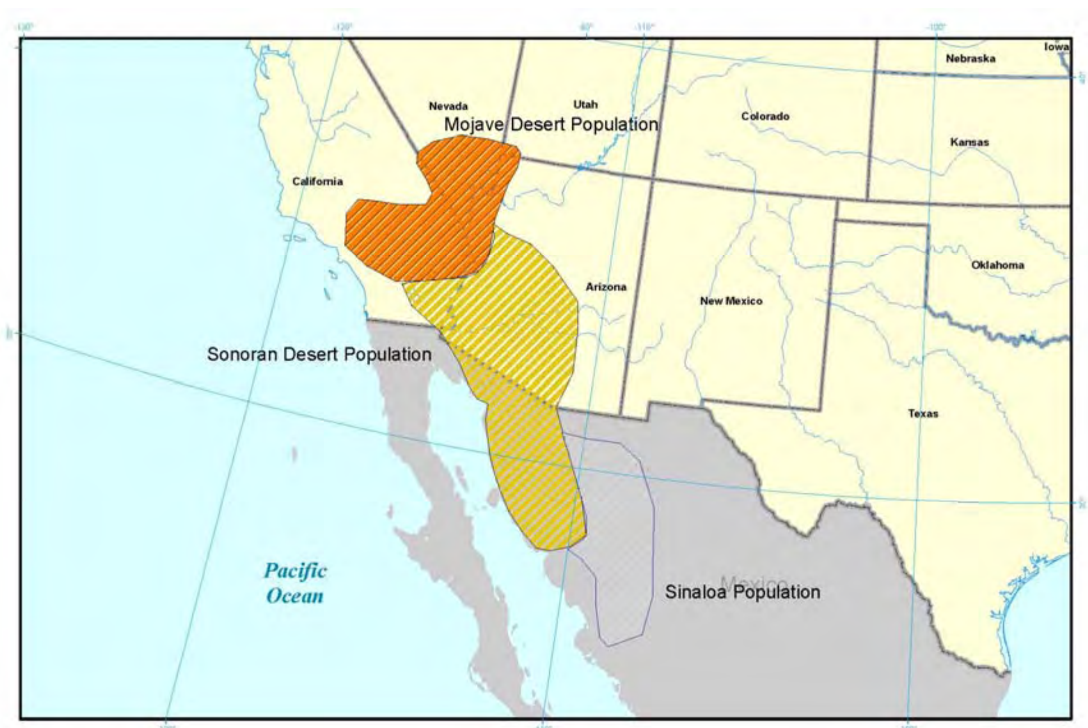

Figure 16. Approximate species distribution of the desert tortoise.

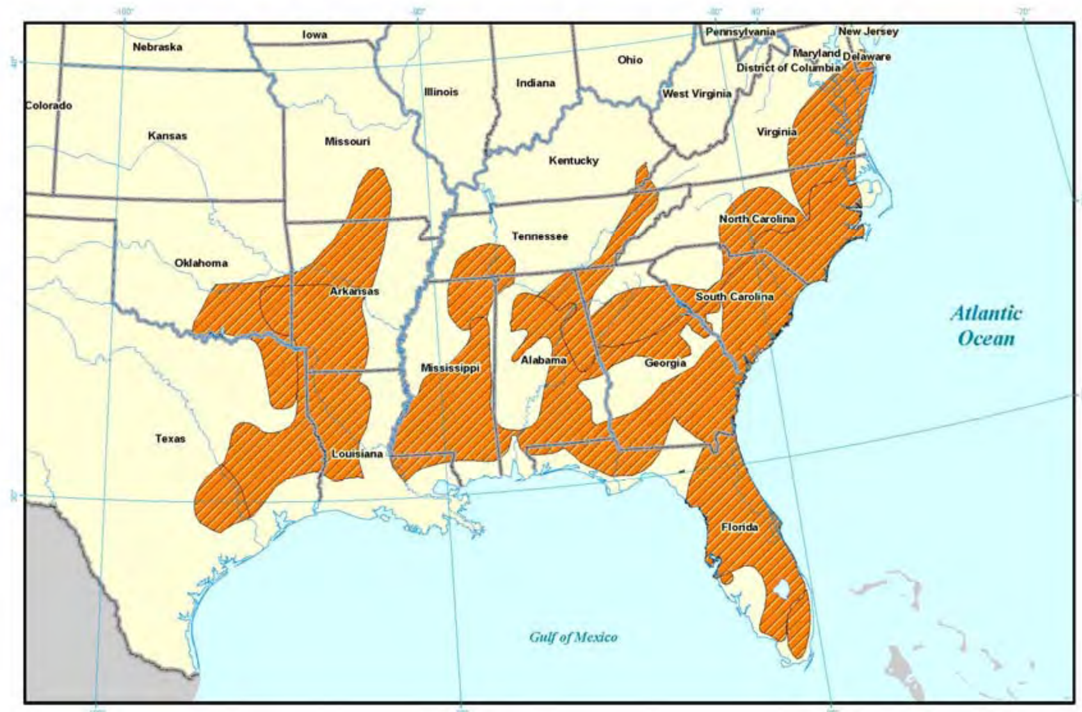

Figure 17. Species distribution of the red-cockaded woodpecker.

Figure 18. Species distribution of the black-capped vireo.

Figure 19. Species distribution of the golden-cheeked warbler.

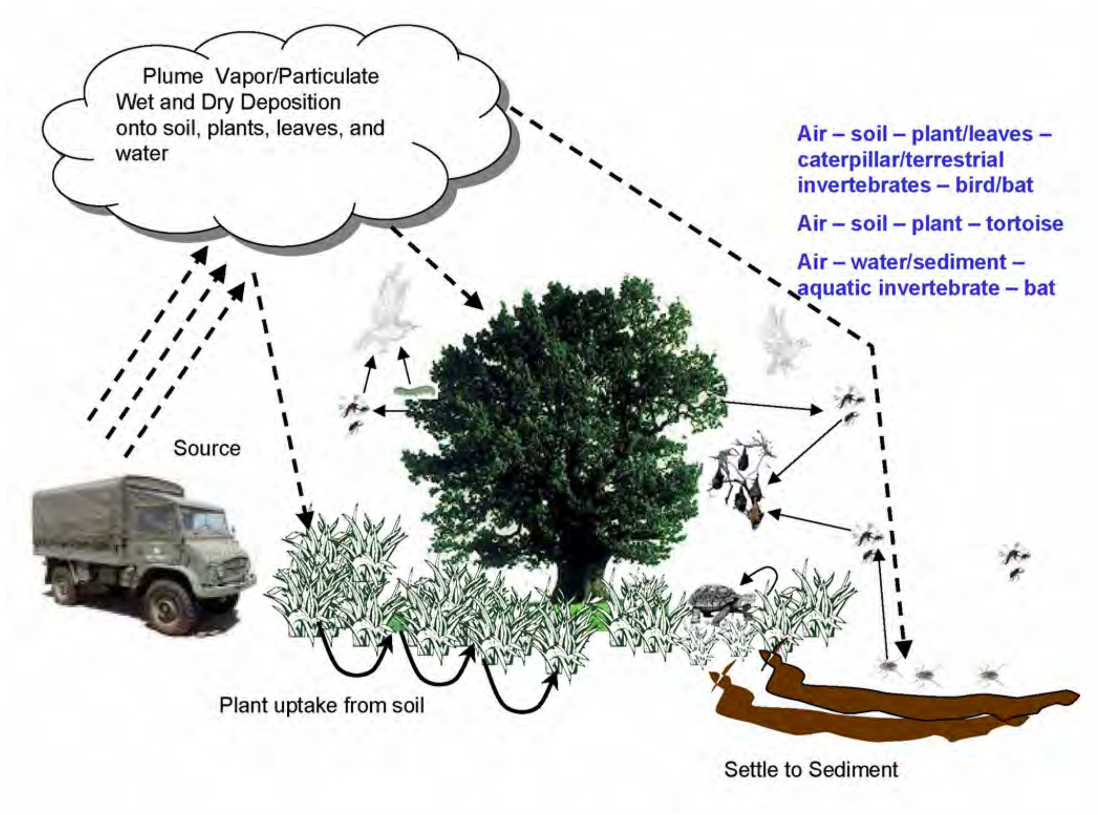

Figure 20. Exposure pathways for smokes and obscurants.

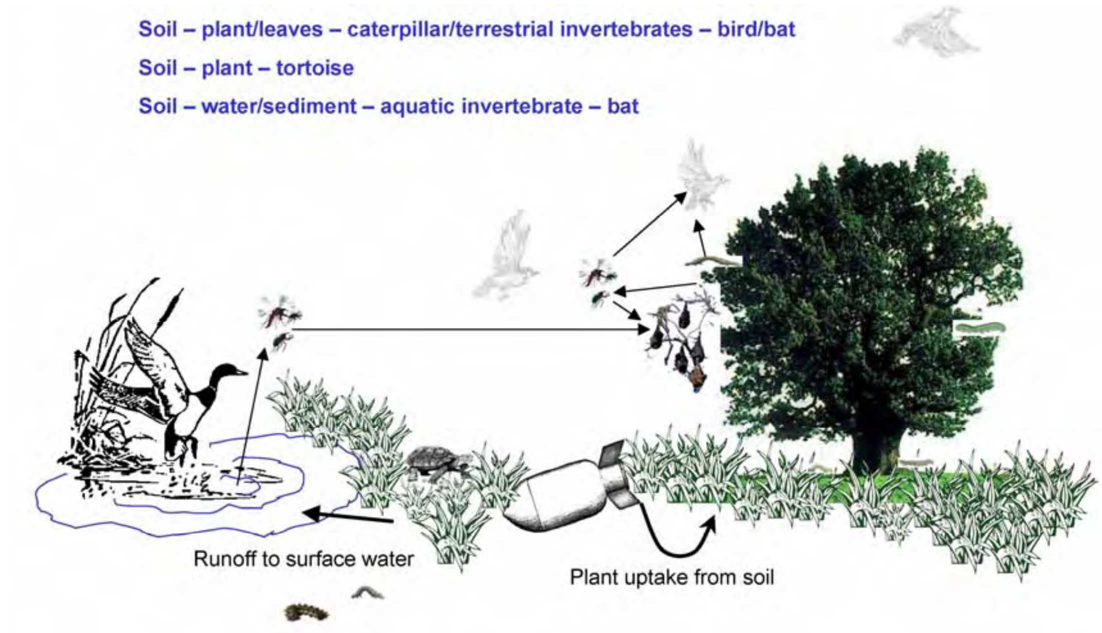

Figure 21. Exposure pathways for munitions.

4 Exposure Assessment

An exposure assessment quantifies the concentrations of contaminants that the receptors of concern are exposed to in the environment. The following procedure was used to estimate doses to receptors of concern at each installation:

1. Determine munition and smoke and obscurant usage at each installation based on data presented in Chapter 2 (page 6).
2. Determine chemical composition of each munition and smoke and obscurant as presented in General Munitions Database)(page 118);
3. Determine the dud and low order firing rate for the munitions as presented in General Munitions Database (page 118);
4. Use maximum estimates from the literature of smoke and obscurant deposition as presented in Expected Soil Concentrations (page 121);
5. Combine the usage statistics with steps 3 and 4 to predict expected soil concentrations;
6. Model uptake into food items (e.g., plants, soil fauna, terrestrial insects, etc.) as presented in Modeling Contaminant Migration (page 122); and
7. Estimate doses to receptors of concern as presented in Profiles for Receptors of Concern (page 89) based on the exposure parameters developed and presented in Predicted Doses to Receptors of Concern (page 125).

Each of these steps will be discussed in the following sections.

Step 1: Determine Constituent Use at Each Installation

Tables 1 through 5 and 7 through 17 provide summaries of ammunition usage at each installation. These are used together with the chemical profiles, as presented in the following section, to obtain the mass of chemical (in grams) found at each installation during 2002.

Step 2: Determine Chemical Profiles of Smokes and Obscurants and Munitions

This section summarizes the chemical properties and constituents of each of the S&Os and MUCs being evaluated. S&Os and MUCs differ in the ways in which they are used and dispersed in the environment and require different ways of esti-

mating potential exposures. S&Os are used to generate cover to hide movement or otherwise distort visual and non-visual wavelengths. Heavy artillery is fired in specifically identified impact areas in order to avoid human contact. Hand-held artillery (e.g., small arms) can be used anywhere on the installation at identified training areas.

General Munitions Database

Each munition is identified by a Department of Defense Identification Code (DoDIC) and is further identified by a National Stock Number (NSN), which is a code given to any piece of equipment used or purchased by the U.S. government. Therefore, each munition type is associated with its own DoDIC/NSN combination, although these may not be unique. In this project, researchers developed a database for each DoDIC identified at each installation that details relevant constituents by percent weight. They used the Defense Ammunition Center (DAC) website (www.dac.army.mil) to access the Munitions Items Disposition Action System (MIDAS), which provides details on munition composition. The TRI Data Delivery System (TRI-DDS) supports munitions demilitarization through open burning (OB) and open detonation (OD) as well as munitions activities on ranges. TRI-DDS provides information on munitions statistics and usage under a self-reporting system. The following data elements are the basic inputs to TRI-DDS as obtained from treatment logs, range usage or scheduling logs and data systems, emergency response and training logs, or other data collection mechanisms:

- DODIC, NSN, drawing number (for components), or common name.
- Description of item (helps with nomenclature search, selecting substitutes for items not in TRI-DDS, and common name pick list selection).
- Quantity used.
- Unit of use.
- Fuels, initiators, and donor charges (if applicable).

However, there are TRI-DDS reporting thresholds so the usage statistics as provided by the installations was used directly. Researchers consulted TRI-DDS to determine the specific munition name for the DoDIC/NSN combination provided by the installations. They developed the following procedure to quantify chemicals based on installation munition usage:

1. Search TRI-DDS by DODIC for the "preferred" NSN.
2. Search MIDAS Database by DoDIC.

- If TRI-DDS indicates a preferred NSN, use datasheet for that NSN.
- If TRI-DDS does not indicate a preferred NSN:
- If only one NSN is in MIDAS, use that entry's datasheet.
- If multiple NSNs are in the MIDAS database:

- Since drawing numbers correspond to engineering revisions,* find an NSN with the highest (latest) drawing number.
- If there are still multiple NSNs with the same drawing number, use the highest NSN by default. Since different NSNs for the same DoDIC refer only to differences in packaging,* the compositions will not differ.

3. Within a datasheet, there may be alternate components or parts, designated by "(ALT)". These alternate parts are used to make munitions only when the manufacturer runs out of the primary parts, so it is safe to assume that the majority of munitions are made of the primary parts.* Only enter COCs from the primary structure of the munition.

- There will be some cases in which a COC is contained in the alternate composition of a part, but not in the primary. Even in this case, use the primary structure components since that composition represents the majority of the munitions produced.

4. Since most tracers are identical to ball projectiles s in composition, aside from the added ignition/illuminatory compounds,* munitions having a ball/tracer format will be entered using the composition of the ball.
5. Some DoDICs are "PROPRIETARY," in which case the composition is not available in MIDAS.

The database provides a detailed accounting of the constituents contained in each munition, which provides the mass of each chemical associated with each individual DoDIC. However, that is not the amount of material that is deposited in the environment. When the munitions fire properly, they typically burn "clean" and do not leave any residual contamination in the environment. However, munitions occasionally fire incorrectly and end up in the environment where the munition constituents may become available to threatened and endangered and other species that come into contact with them. This is referred to as a "dud" or low order detonation. A dud is a round that is fired, but fails to function and ultimately either penetrates the ground or comes to rest on the surface without firing (Dauphin and Doyle 2000). A low order detonation occurs when a high explosive round is fired, but functions only partially at the target such that part of the filler detonates and part of it does not. A misfire occurs when and an attempt is made to fire (e.g., pulling a trigger or dropping a mortar round down the tube) and nothing happens. In this case, nothing leaves the weapon and is not considered in estimates of the dud and low order detonation rates.

* Personal communication, U.S. Army Defense Ammunition Center – MIDAS database administrator, February 2004.

Dauphin and Doyle (2000, 2001) conducted a study of ammunition and dud and low order detonation rates for a number of ammunition types. Researchers in this study evaluated these reports to determine the dud rate percentage applicable to each munition type. Dauphine and Doyle (2000, 2001) did not evaluate small arms munitions (.50-caliber and below) as these items have non-explosive projectiles or only small tracer elements or incendiary charges and are therefore not assumed to contribute appreciably to environmental concentrations of chemicals.

The average dud rate for typical munitions is approximately 3 percent. The highest reported dud rate for any munition is approximately 18 percent for colored smoke grenades. However, this screening level assessment assumes that 100 percent of the colored smoke found in a grenade has the potential to disperse in the environment (that is, this report assumes there is no dud rate for colored smokes). In addition, this screening level assessment assumes two different dud rates across all munition types (with the exception of the colored smoke grenades):

- 10 percent (higher than the average dud rate given in Dauphin and Doyle [2000] and is considered a conservative estimate); and,
- 100 percent (assumes the entire mass of contaminant in the munitions is available for uptake into the food web).

A number of grenade types or formulations are used to administer various S&Os, particularly the colored smokes. The mass of dye in each of these is evaluated in its entirety, rather than applying the dud rate, since one expects the cloud to deposit each time. Since the exact location for use of these grenades is unknown, researchers assume that the entire mass of material contained in the colored smoke grenades will land on the same area as the munitions (e.g., the impact area). As these clouds are typically low to the ground and do not drift appreciably, researchers did not incorporate deposition estimates but rather conservatively worked with the entire mass of material being taken up in plants.

The list of constituent concentrations obtained via this method include:

2,4-Dinitrotoluene
Dinitrotoluene (mixed isomers)
HMX
Dinitrobenzene
Nitroglycerin
PETN
RDX
Tetryl
TNT
Hexchloroethane (HC)
Terephthalic acid
White Phosphorus

(o-chlorobenzol)-malonitrile (CS)
CI Basic Yellow 2
CI Disperse Yellow 11
Dibenz(b,f)-1,4-oxazepine (CR)
Disperse Red 9
Dye Solvent Green 3
Dye Solvent Yellow 33
Dye Yellow 4
Dye Yellow Smoke 6
Red Phosphorus
Titanium Dioxide

Several of the COCs are breakdown products from TNT, RDX, and HMX. These include 1,3,5-trinitrobenzene, 1,4-dinitrobenzene, dinitrophenol, nitrobenzene, and nitrophenol isomers. There are no data in MIDAS for these constituents as they are not directly part of any munitions. Talmage et al. (1999) suggests that 1,4-dinitrobenzene is typically less than 1 percent of the TNT concentration found, and that 1,3,5-trinitrobenzene is very similar to 1,4-dinitrobenzene. For this analysis, researchers assumed that 1,3,5-trinitrobenzene and 1,4-dinitrobenzene are present at 10 percent of the TNT value. They were unable to quantify the remaining compounds. Monitoring data from an installation could be evaluated to determine the relative proportion of these constituents as compared to TNT, RDX, and/or HMX. This ratio could then be applied across all installations in the absence of site-specific data.

Smokes and obscurants

S&Os differ from munitions in that the conceptual model involves the settling of residual smoke vapor and particles onto soil, leaves, and prey items for the selected threatened and endangered species. Although it is theoretically possible for S&O constituents deposited onto soils to be subsequently taken up by plants, there is virtually no data available to quantify this process. This analysis assumes that the entire quantity of S&O used in a given year at an installation deposits onto plants and is available for uptake by prey items. This is a conservative assumption given that it is likely there will be loss processes including precipitation, losses due to wind, and other local climactic influences.

The TRI-DDS/MIDAS procedure described above was used for hexachloroethane, white phosphorus, red phosphorus, colored smoke, and terephthalic acid. Researchers relied on the installations to provide details on graphite flakes, fog oil, and brass flakes. Researchers did obtain usage statistics for fog oil, but none of the installations provided quantitative information on graphite and brass flake usage.

Expected Soil Concentrations

This section summarizes calculations of expected soil concentrations for all the COCs except fog oil, and including colored smokes (which are usually used as part of different grenade types). Fog oil and fog oil additives are deposited directly onto tree foliage and plants; therefore expected concentrations of these COCs in the environment are estimated for tree foliage and plants and not in soil.

The predicted concentration in soil is given as:

$$C_{soil} = \frac{C \times COC_{mass}}{A \times D \times Dens} \qquad \text{[Equation 1]}$$

where:

C_{soil}	=	concentration in soil (mg/kg).
COC_{mass}	=	mass of munition/colored smoke from database (total amount used * 10% dud rate; grams).
A	=	site-specific area over which munitions end up (typically the impact area; square miles.
D	=	dry depth of soil (cm).
Dens	=	dry soil bulk density (2.65 g/cm^3).
C	=	conversion factor (3.86x10-11mi^2/cm^2*10^{-6}mg/kg).

Modeling Contaminant Migration

This section summarizes calculations of COC concentrations in food items of threatened and endangered species of concern. COC concentrations in tree foliage and plants, terrestrial insects, and aquatic insects are calculated using modeling of chemical migration.

Predicted concentrations in tree foliage and herbaceous plants

Above-ground herbaceous plants and tree leaves are consumed by a number of threatened and endangered species or are consumed by other food (i.e., prey items) of those species (e.g., caterpillars and beetles). Chemicals can reach tree foliage and herbaceous plants by:

- Direct wet and dry deposition of S&O clouds following training exercises;
- Root uptake of both S&Os and MUCs from soil; and,
- Soil-to-plant "splash" transfer of both S&Os and MUCs to low-lying herbaceous plants.

This analysis quantifies the deposition of S&O clouds and root uptake from soil for MUCs. One expects the soil-to-plant "splash" transfer to be low compared to direct deposition, particularly considering that most, if not all, soils are covered by plants (ranging from grasses to trees) and so very little of the S&O actually reaches the soil. For the munitions, which are deposited directly on the ground, this is not the case, and one assumes that all material is available for uptake by plants.

Fog Oil

Fog oil is potentially deposited onto plants and tree foliage via both wet and dry deposition of particulate matter found in the smoke cloud. This analysis relies on fog oil modeling results presented in Getz et al. (1996) based on Driver et al. (1993), which provides estimated environmental concentrations of fog oil following a 2-hr smoking exercise. This "worst-case" scenario (Getz et al. 1996) incorporates the following assumptions:

- The smoking exercise is 2 hours in length (most smoke training exercises last 30 to 90 min);
- The release rate is 80 gal (302 liters) per hour per generator with a total release of 160 gal per generator; and
- An area 1 km by 1 km is smoked (the cloud can be wider but less material would be deposited).

The following equation is used to estimate the concentration of fog oil and fog oil additives on plants and tree foliage:

$$C_{plant} = \frac{V_{fogoil} \times Dens_{fogoil}}{A \times P} \qquad \text{[Equation 2]}$$

where:

C_{plant}	=	concentration on plants (mg/kg ww).
V_{fogoil}	=	amount of fog oil deposited (gals).
$Dens_{fogoil}$	=	density of fog oil (0.92 g/cm^3).
A	=	area over which fog oil is used (assumed to be 1 km by 1 km square or 0.39 mi^2).
P	=	plant yield (plants grass – 1 kg ww/m^2 and tree leaves = 1.5 kg ww/m^2).
C	=	conversion factor (3785 cm^3/gallons*1000mg/g*3.86x10^{-8}mi^2/m^2).

Munitions and Colored Smokes

In this screening level assessment, root uptake is considered the dominant pathway by which munitions and colored smokes reach plants and tree foliage. The equation is given as:

$$C_{plant} = 7.7 \times K_{ow}^{=-0.58} \times C_{soil} \qquad \text{[Equation 3]}$$

where:

C_{plant} = concentration in leaves and tree foliage via root uptake (mg/kg ww).

K_{ow} = octanol-water partitioning coefficient.

C_{soil} = concentration in soil (mg/kg dw).

Predicted concentrations in terrestrial insects

Several of the selected threatened and endangered species are known to consume a wide variety of arthropods, in particular terrestrial insects that are found in and among trees and other habitats. Many of these insects primarily consume leaves (i.e., tree leaves, grass leaves, etc.). For this analysis, assume that the insects are in equilibrium with predicted chemical concentrations in the tree leaves (as derived in the previous section). The equilibrium calculation is given as:

$$C_{terrinsect} = \frac{C_{leaf} \times L_{insect} \times C}{L_{leaf}} \qquad \text{[Equation 4]}$$

where:

$C_{terrinsect}$ = concentration in terrestrial insects (mg/kg ww).

C_{leaf} = concentration in the leaf (mg/kg ww).

L_{insect} = lipid content of insects (10.5% dry weight).

L_{leaf} = lipid content of tree leaves (0.5% wet weight).

C = 0.29 dry weight insects / wet weight insects.

The lipid content of tree leaves was obtained from Nutrition Analysis Tool and System version 1.1 at http://www.ag.uiuc.edu/~food-lab/nat/mainnat.html. The value is for an average lipid content of green leaf lettuce, Romaine lettuce, kale, collards, and chard. Although these are leafy vegetables (which does correspond to the yield estimates from Baes et al. 1984), the leaf structure and composition is similar as for herbaceous plants as well as leafy green trees. The lipid content of insects typically ranges from 1 to 10 percent with a wet to dry conversion factor of 0.29 obtained from U.S. Department of Energy (1998).

Predicted concentrations in aquatic insects

Chemicals found in S&Os can land directly on water bodies within the deposition area of the cloud. Some of the material will volatilize from the water, but some of it will “partition” onto particles in the water column and eventually settle into the sediments. Once in the sediment, emergent aquatic insects can be exposed to chemicals in the sediment while in their larval stage. Typically, these insects will then travel through the water column and emerge from the water where they may

become prey items for the identified bats and birds in general. Predicted concentrations in sediment are given as:

$$C_{sed} = \frac{V_{fogoil} \times Dens_{fogoil} \times C}{A \times Dens_{sed} \times D} \qquad \text{[Equation 5]}$$

where:

C_{sed} = concentration in sediment (mg/kg dw).
V_{fogoil} = volume of fog oil deposited onto water body (gallons).
$Dens_{fogoil}$ = density of fog oil (0.92 g/cm^3).
A = area over which fog oil is deposited (1 km by 1 km or 0.39 mi^2).
$Dens_{sed}$ = density of dry sediment (2.65 g/cm^3).
D = depth of dry sediment (1 cm).
C = conversion factor (3785 cm^3/gallons*3.86x10^{-11}mi^2/cm^2*10^{-6}mg/kg).

The concentration in benthic invertebrates (i.e., aquatic insects) is given as:

$$C_{benth} = \frac{C_{sed} \times L_{benth} \times C}{TOC} \qquad \text{[Equation 6]}$$

where:

C_{benth} = predicted concentration in benthic invertebrates (mg/kg ww).
C_{sed} = concentration in sediment (mg/kg dw).
L_{benth} = lipid content of benthic invertebrates (10.5% dry weight).
TOC = total organic carbon of sediment (1.5%).
C = 0.29 dry weight insects / wet weight invertebrates.

Chemicals found in S&Os and munitions can runoff from soils into water and settle to the sediments. Similarly, aquatic insects in their larval stage can be exposed to these chemicals in the water column prior to larval emergence from the water. This exposure pathway is not quantified in this screening level assessment.

Predicted Doses to Receptors of Concern

Table 18 provides a summary of exposure parameters for the threatened and endangered species of concern based on information from Profiles for Receptors of Concern (page 89). The general equation for predicting doses to the threatened and endangered species of concern is given as:

$$Dose_{tes} = \frac{\Sigma C_{preyitem} \times IR_{preyitem}}{BW} \qquad \text{[Equation 7]}$$

where:

$Dose_{TES}$ = dose to receptor (mg/kg bw-day).

$C_{preyitem}$ = concentration in plants, terrestrial insects, aquatic insects.

$IR_{preyitem}$ = ingestion rate for the specific prey item.

BW = receptor body weight (kg).

The exposure summaries are provided as part of the Risk Characterization and in Tables 26 through 40. (These tables are at the end of Chapter 6, beginning on page 160.)

5 Effects Assessment

This chapter provides toxicity profiles for the S&Os and MUCs being evaluated and develops TRVs for comparison of predicted doses to the selected threatened and endangered species to ascertain the potential for adverse effects as a result of expected exposures.

The general approach was to:

- Conduct a literature review;
- Characterize the types of studies for developing the TRV;
- Specify a method for deriving TRVs; and
- Select the TRVs for receptors of concern.

Literature Review

A search of the primary literature was conducted through the following sources: Cambridge Scientific Abstracts, National Library of Medicine (NLM) TOXNET, which includes Hazardous Substances Data Base (HSDB), Integrated Risk Information System (IRIS), GENE-TOX, Chemical Carcinogenesis Research Information System, TOXLINE, Developmental and Reproductive Toxicology and Environmental Teratology Information Center, Toxics Release Inventory (TRI), USEPA's ECOTOX, and references contained in retrieved articles (e.g., Von Stackelberg et al. 2004, 2005).

Characterize the Types of Studies for Developing the TRV

Results of studies identified in the literature review were characterized according to the following criteria:

A. Use population-level endpoints. Where possible, researchers used reproductive endpoints. Toxicity endpoints that are related to adverse impacts on survival, growth, or reproduction are thought to have greater potential for adverse effects on populations of organisms than endpoints that are related to other effects. For example, changes in behavior, disease, cell structure, immunological responses, and hormonal or biochemical changes may affect individual organisms, but may not result in adverse effects at the population level. Therefore, researchers may discuss

studies that examine the effects of COCs on other sublethal endpoints but not use them to select TRVs. In general, researchers assumed that effects on reproduction represent a more sensitive endpoint than growth or mortality of adult organisms. This may not always be the case.

B. Use chronic studies. Researchers preferentially used studies of chronic exposure to select TRVs. In cases where exposures are expected to be long-term, data from studies of chronic exposure are preferable to data from medium-term (subchronic), short-term (acute), or single-exposure studies (USEPA 1997).

C. Use dose response studies. Where possible, researchers used studies that exhibited a dose response and could provide doses from above and below the threshold level examined in the study. Such dose-response studies compare the response of organisms exposed to a range of doses to that of a control group. The toxicity metrics derived from dose-response (and other) studies include:

- NOAEL (No Observed Adverse Effect Level) or NOEC (No Observed Effect Concentration). The NOAEL or NOEC is the highest exposure level shown to be without adverse effect in organisms exposed to a range of doses. NOAELs may be expressed as dietary doses (e.g., mg COC consumed/kg body weight/day) or as a concentration in food. In some cases for the COC/COPC for this study where the transport is to soil or foliar surfaces, the NOEC was expressed as concentration per area (ug/cm^2);
- LOAEL (Lowest Observed Adverse Effect Level) or LOEC (Lowest Observed Effect Concentration). The LOAEL or LOEC is the lowest exposure level shown to produce an adverse effect in organisms exposed to a range of doses. LOAELs may be expressed as dietary doses (e.g., mg COC consumed/kg body weight/day). The LOAEL represents a concentration at which the particular effect has been observed and the occurrence of the effect is statistically significantly different from the control organisms. In some cases for the COPCs for this study where the transport is to soil or foliar surfaces, the NOEC was expressed as concentration per area (ug/cm^2);
- LD_{50}. The LD_{50} is the Lethal Dose that results in death of 50 percent of the exposed organisms. The LD_{50} is expressed in units of dose (e.g., mg COC administered/kg body weight of test organism);
- LC_{50}. The LC_{50} is the Lethal Concentration in some external media (e.g., food, water, or sediment) that results in death of 50 percent of the exposed organisms. The LC_{50} is expressed in units of concentration (e.g., mg COC/kg wet weight food);
- ED_{50}. The ED_{50} is the Effective Dose that results in a sublethal effect in 50 percent of the exposed organisms (mg/kg/day);

- EC_{50}. EC_{50} is the Effective Concentration in some external media that results in a sublethal effect in 50 percent of the exposed organisms (mg/kg) or as a concentration in tissues (e.g., mg COC/kg tissue);
- EL-effect. EL-effect is the effect level that results in an adverse effect in organisms exposed to a single dose, rather than a range of doses [expressed in units of dose (mg/kg/day) or concentration (mg/kg)] or as a concentration in tissues (e.g., mg COC/kg tissue);
- EL-no effect. EL-no effect is the effect level that does not result in an adverse effect in organisms exposed to a single dose, rather than a range of doses [expressed in units of dose (mg/kg/d) or concentration (mg/kg)] or as a concentration in tissues (e.g., mg COC/kg tissue).

D. Use NOAELs and LOAELs. Most USEPA risk assessments typically estimate risk by comparing the exposure of receptors of concern to TRVs derived from NOAELs. The TRVs for this assessment are derived from NOAELs and LOAELs to provide perspective on the range of potential effects relative to measured or modeled exposures.

E. Select TRVs on the basis of the most likely route of exposure. Differences in feeding behaviors among organisms determine the type of toxicity endpoints that are most easily measured and most useful in assessing risk. In some studies, doses are administered via gavage, intraperitoneal injection into an adult, or injection into a fish or bird egg. TRVs for the present risk assessment are selected on the basis of the most likely route of exposure, as described below:

- TRVs for soil invertebrates are expressed as concentrations in external media (e.g., mg/kg soil) and as a mass of contaminant deposited per unit area of soil (ug/cm^2).
- TRVs for plants are expressed as concentrations in external media (e.g., mg/kg soil or foliage) and as a mass of contaminant deposited per unit area of soil or foliage (ug/cm^2).
- TRVs for reptiles, birds, and mammals are expressed as daily dietary doses (e.g., mg/kg whole body wt/day).

Use TRVs that bracket the range of risks to address uncertainty.

F. Consider the use of appropriate field studies to derive TRVs, where available. The literature on toxic effects includes laboratory and field studies. Each type of study has advantages and disadvantages for deriving TRVs. Laboratory studies can control for co-occurring contaminants, thus providing greater confidence in the conclusion that observed effects are related to exposure to the test compound. Field studies have the advantage that organisms may be exposed to a more realistic mixture of COCs than are organisms that are exposed to technical grades in the laboratory. Field studies have the disadvantage that organisms are often exposed to other

contaminants and observed effects may not be attributable solely to exposure to a given COC.

Laboratory studies often use species that are easily maintained in the laboratory, rather than wildlife species that may be more closely related to a particular receptor of concern. Field studies may be used most successfully to establish concentrations of COCs at which adverse effects are not observed (e.g., a NOAEL).

If appropriate field studies are available, those field studies may be used to derive NOAEL TRVs for receptors of concern. Appropriateness of a field study depends on whether:

- the study examines sensitive endpoints, such as reproductive effects, in a species that is closely related (e.g., within the same taxonomic family) to the receptor of concern;
- measured exposure concentrations of COCs are reported for dietary doses or whole organisms;
- the study establishes a dose-response relationship between exposure concentrations of COCs and observed effects; and
- contributions of co-occurring chemicals are reported and considered to be negligible in comparison to the contribution of COCs.

Use laboratory studies if appropriate field studies are not available for a test species in the same taxonomic family as the receptor species.

Methodology to Derive TRVs

This section describes the general methodology to derive TRVs from appropriate studies for receptors of concern. When appropriate chronic-exposure toxicity studies on the effects of COCs on lethality, growth, or reproduction were not available for a selected threatened and endangered species, researchers extrapolated from other studies to estimate appropriate TRVs. This method follows the general protocols employed elsewhere (e.g., Sample et al. 1996, California EPA 1996, USEPA 1996). The general methodology to develop LOAEL and NOAEL TRVs followed several steps.

1. If an appropriate NOAEL and LOAEL was unavailable for the species of concern or for a phylogenetically similar species (e.g., within the same taxonomic family), the assessment developed TRV values from studies conducted on other species, and used the highest appropriate NOAEL whenever several studies were available.
2. In the absence of an appropriate NOAEL and if an LOAEL was available for a phylogenetically similar species, researchers divided by an uncertainty factor of

10 to account for an LOAEL-to-NOAEL conversion, except where noted. The LOAEL-to-NOAEL conversion is similar to USEPA's derivation of a human health Reference Dose (RfD).

3. When calculating chronic dietary dose-based TRVs (e.g., mg/kg-day) from data for sub-chronic tests, the sub-chronic LOAEL or NOAEL values were divided by an uncertainty factor of 10 to estimate chronic TRVs. The use of an uncertainty factor of 10 is consistent with the methodology used to derive human health RfDs. These factors are applied to account for uncertainty in using an external dose (mg/kg/day in diet) as a surrogate for the dose at the site of toxic action (e.g., mg/kg in tissue). Since organisms may attain a toxic dose at the site of toxic action (e.g., in tissues or organs) via a large dose administered over a short period, or via a smaller dose administered over a longer period, uncertainty factors are used to estimate the smallest dose that, if administered chronically, would result in a toxic dose at the site of action. USEPA has not established a definitive line between sub-chronic and chronic exposures for ecological receptors. The present risk assessment follows recently developed guidance (Sample et al. 1996), which considers 10 weeks to be the minimum time for chronic exposure of birds and 1 year for chronic exposure of mammals.
4. In cases where NOAELs are available as a dietary concentration (e.g., mg contaminant per kg food), a daily dose for birds or mammals is calculated on the basis of standard estimates of food intake rates and body weights (e.g., USEPA 1993 and Sample et al. 1996).

Tables 20 through 22 provide the selected TRVs for plants, birds, and mammals for the S&Os, respectively, and Tables 23 through 25 show the selected TRVs for plants, birds, and mammals for the MUCs, respectively.

Amphibians and reptiles

In general, there are very few studies available for any contaminant conducted specifically for reptiles and/or amphibians. For the present study, researchers conducted an extensive literature review, and found no toxicity information for tortoises for the MUCs. Sources of information reviewed included standard journal search engines such as Cambridge Scientific Abstracts (CSA), and compilations of toxicity information such as the USEPA's ECOTOX online database, the Society for Environmental Toxicology and Chemistry compilation (Jarvinen and Ankley 1999) and the Army Corps of Engineers online Environmental Effects Database. As summarized by Sparling et al. (2000), little toxicity information is available for reptiles, and what little that exists is a statement of this fact. Since there are virtually no toxicity data for reptiles, the adjusted benchmark for the tortoise was calculated by dividing the test mammal NOAEL or LOAEL by an uncertainty factor of 10 to extrapolate from the test species to a target species. The interclass uncertainty fac-

tor of 10 is in accordance with existing procedural protocol (California EPA 1996). Thus, TRVs for the reptiles and amphibians are the mammalian TRVs divided by a factor of 10.

TRVs for individual COCs

Fog Oil

Fog oil has characteristics that make it similar to No. 1 and No. 2 fuel oils and lubricating oils. Analyses of fog oil show a variety of individual constituents, including aliphatics, substituted indanes, naphthalenes, tetrahydronaphthalenes, biphenyls, and mulitalkyl polycyclic aromatic hydrocarbons. The exact composition of fog oil differs from batch to batch and also depends on the combustion characteristics.

Much of the toxicity data for fog oil has been developed using materials other than the type of fog oil currently in use in the military, SFG-2. Some of these materials are substantially similar to fog oil (i.e., white mineral oil, 10-W and 10-W-30 lubricating oils, etc.) while others (i.e., diesel fuel) contain higher concentrations of toxic compounds such as polycyclic aromatic hydrocarbons. Therefore, in developing TRVs for fog oil, researchers limited their review to the materials with a greater similarity to the type of fog oil that is in current use.

Schaeffer et al. (1986) concluded that plants and animals exposed to smokes at Fort Irwin, CA, are at a toxicologically higher risk for several types of damage than control organisms, although the study was unable to discern the ecological significance of the observed effects. However, the data suggest there is the potential for adverse effects resulting from chronic exposure to fog oil use.

Cataldo et al. (1989a) studied effects of SFG-2 fog oil on plants and invertebrates through deposition on soil or deposition on foliage. For invertebrates, they reported a “no effects” concentration in soil of 160 mg/kg and the lowest concentration at which effects were observed of 285 mg/kg. Therefore, for the current study, researchers selected these values as the NOEC and LOEC, respectively. The plants studied by Cataldo et al. (1989a) included ponderosa pine (*Pinus ponderosa*), short needle pine (*Pinus* sp.), sagebrush (*Artemesia* sp.), and tall fescue (*Festuca arundinaceae*) (a grass). The lowest concentration to produce an effect on plants was 69 $\mu g/cm^2$ of leaf surface. This value was selected as the LOEC. The highest concentration associated with no effects, but below this value, was 55 $\mu g/cm^2$ on the leaf surface, and it was selected as the NOEC. In addition, Cataldo et al. (1989a) reported a NOEC in soil of 330 $\mu g/cm^2$ for tall fescue. They did not report a level at which effects were observed.

There was little information available for the toxicity of fog oil to birds. Hartung and Hunt (1966) reported single doses of lubricating oils up to 17,000 mg/kg produced no adverse effect on ducks. They also reported no renal or hepatic effect on ducks given single doses of 1,700 mg/kg lubricating oil. This information is insufficient to develop an LOAEL or NOAEL for fog oil for birds.

The information for mammals is similarly as sparse. Smith et al. (1995) reported that a concentration of 1,500 mg/kg of white mineral oil in food did not produce an effect over 90 days when fed to rats. Since an LD^{50} of 5,000 mg/kg is available for fog oil for rats (Mayhew et al. 1986), these two values can be used to estimate an NOAEL and LOAEL of 12 and 50 mg/kg/day, respectively. The resulting calculated NOAEL and LOAEL for reptiles are 1.2 and 5 mg/kg/day, respectively.

Graphite Flakes

Relatively little toxicity data was available for graphite flakes. Bowser et al. (1990) reported a soil concentration of 10,000 mg/kg that did not cause adverse effects to earthworms. However, since they did not report any concentrations that did cause adverse effects, researchers were unable to calculate a NOEC or LOEC from this value.

No effects on growth were reported for plants (corn and cucumbers) due to graphite flakes at concentrations up to 50 mg/kg (Phillips and Wentsel 1990). Philips and Wentsel did not provide a concentration at which adverse effects were observed. Therefore, researchers are unable to derive a NOEC or LOEC for graphite flakes for plants.

No toxicity information was available on the effects of graphite flakes in the diet on birds.

No reports of toxicity to mammals were identified in the literature. Manthei et al. (1980) studied acute toxicity of graphite flakes. Their highest single dose via gavage of 5,000 mg/kg body weight did not produce adverse effects in a rat. Because no effects data were available, researchers are unable to calculate a NOAEL or LOAEL from these data.

Brass Flakes

Brass flakes, an alloy typically composed of approximately 70 percent copper and 30 percent zinc, are used to block detection by infrared waves. Also, trace amounts of aluminum (0.2 percent), antimony (0.1 percent), and lead (0.1 percent) have been detected, and there may be other inorganic contaminants at concentrations close to

or below typical detection limits (National Research Council [NRC] 1999). The predicted fate and effects of brass flakes depends not only on the composition of the alloy, but also on the size of the individual particles, which is variable, and on whether or not specific coatings have been used. Typical coatings include palmitic and/or stearic acid, which make the powder float on water surfaces.

Many studies have documented that elevated concentrations of copper and or zinc, in and of themselves, can have detrimental impacts on biological communities (Hodson and Sprague 1975, Horne and Dunson 1995). Environmental fate, and toxicity, of brass flakes is regulated by the speciation of zinc and copper in the environment.

Hexachloroethane Smoke

Hexachloroethane smokes are generated from a pyrotechnic mixture containing aluminum, zinc oxide, and hexachloroethane. Combustion of this mixture produces predominantly zinc chloride, which rapidly absorbs moisture from the surrounding air to form a grayish-white smoke. Other constituents that are formed include aluminum oxide, carbon tetrachloride, tetrachloroethane, hexachlorobenzene, unreacted hexachloroethane and possibly phosgene (Cataldo et al. 1989a, Sadusky et al. 1993, Karlsson et al. 1986, Katz et al. 1980). Zinc chloride is corrosive and a known epithelial tissue irritant, and has been found to be primarily responsible for adverse effects associated with exposures to hexachloroethane smoke (Karlsson et al. 1986, Sadusky et al. 1993).

Sadusky et al. (1993) used open-top chambers to determine the relationships between hexachloroethane smoke, zinc deposition, and foliar injury of tree species indigenous to military training facilities. Exposures were characterized as:

Dose Level	Zinc Deposition (mg Zn/plot)	Zinc Deposition (μg Zn/cm^{2})
0X	22	0.3
1X	452	6.4
2X	513	7.3

Plot diameter was 3 meters and the area of the plot = 3.14 (150 cm)^2 = 70,700 cm^2

A study by the Health Effects Research Division of the U.S. Army Biomedical Research and Development Laboratory (Cataldo et al. 1989a) observed symptoms of necrotic leaf spot, chlorotic mottle, marginal leaf necrosis, and defoliation in black locust and black cherry trees 7 days following exposures.

TRVs estimated from this study, based on effects to black locust (*Robina pseudoacacia*) and black cherry (*Prunus serotina*) trees are:
LOAEL = 6.4 μg Zn/cm².
NOAEL = 0.3 μg Zn/cm².

Tall fescue and bushbean were most susceptible, with significant foliar damage (based on Daubenmire damage rating of 2.0 or greater) evident at approximately foliar mass loadings of 5μg Zn/cm². Other species (ponderosa pine and sagebrush) exhibited detectable damage at approximately 20 μg Zn/cm². Damage symptoms included chlorosis, necrotic spotting, tip or leaf burn, and in extreme cases, leaf drop.

TRVs based on effects observed in tall fescues are:
LOAEL = 5 μg Zn/cm².
NOAEL = 3 μg Zn/cm².

Sample et al. (1996) developed TRVs for zinc for mammals based on a study in which rats were exposed through the diet during days 1 through 16 of gestation. This is considered equivalent to a chronic exposure because it occurs during gestation, which is considered to be a critical lifestage. The study found increased rates of fetal resorption and reduced fetal growth rates. TRVs based on effects in rats are:
Chronic LOAEL = 320 mg/kg/d.
Chronic NOAEL = 160 mg/kg/d.

Sample et al. (1996) also provides TRVs for zinc for avian effects based on a study on white leghorn hens exposed in diet for 44 weeks (> 10 weeks and during critical life stage is considered a chronic study). The study found reduced egg hatchability (< 20 percent of controls). The TRVs based on effects in chickens are:
Chronic LOAEL = 131 mg/kg/d.
Chronic NOAEL = 14.5 mg/kg/d.

White Phosphorus

During the 1980s and 1990s, waterfowl mortalities were observed in Eagle River Flats, a site associated with Fort Richardson near Anchorage, Alaska. Those mortalities were attributed to waterfowl ingestion of white phosphorus (P_4) particles (Racine et al. 1992). As a result, the effects of P_4 on waterfowl have been examined. Ducks are very susceptible to P_4 intoxication and have been the focus of many laboratory studies with P_4 (Steele et al. 1997, Sparling et al. 1998, Roebuck et al. 1998, Vann et al. 2000). Studies show that the physiological tolerance to P_4 among five species of ducks was very similar (Steele et al. 1997) and P_4 particle size does not

influence P_4 toxicity (Roebuck et al. 1998) to dabbling ducks. A dose of 12 mg P_4/kg body weight results in death of farm-raised mallards (*Anas platyrhynchos*) (Roebuck et al. 1998). Reproductive effects in the mallard (e.g., teratogenic defects and impacts on egg laying) resulted at a dose of 0.5 mg/kg/day given over 7 days (Vann et al. 2000). This same dose and exposure duration also resulted in renal and hepatic impairment as indicated by blood tests (Sparling et al. 1998).

In addition, the potential for secondary poisoning of avian predators [e.g., eagles, herring gulls (*Larus argentatus*) and ravens (*Corvus corax*) are known to consume sick/poisoned waterfowl] has been investigated (Nam et al. 1994, Sparling and Federoff 1997). P_4 can biotransfer from prey to predator (Nam et al. 1994) and, at 0.62 mg/kg/d in prey, cause P_4 intoxication (Sparling and Federoff 1997).

The sublethal studies with mallards conducted by Vann et al. (2000) and Sparling et al. (1998) were used to develop chronic dietary TRVs for birds. Both studies selected sensitive, ecologically-relevant endpoints with species sensitive to P_4 toxicity. Both the studies by Vann et al. (2000) and Sparling et al. (1998) were conducted over 7 days, which is not considered to be a chronic exposure period. Therefore, the effective dose (0.5 mg/kg/day) was divided by a subchronic to chronic factor of 10 resulting in a LOAEL TRV of 0.05 mg/kg/day. The NOAEL was derived from the LOAEL by dividing by a LOAEL-to-NOAEL factor of 10 resulting in a NOAEL of 0.005 mg/kg/day. These TRVs should also be protective of avian predators, which may consume P_4-intoxicated ducks. Based on these studies:
The P_4 NOAEL TRV for birds is 0.005 mg/kg/day.
The P_4 LOAEL TRV for birds is 0.05 mg/kg/day.

The effects of P_4 to mammals are summarized in the Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profile for white phosphorus (ATSDR 1997). In developing TRVs, preference was given to chronic oral studies. When administered orally to rats, a dose of 0.075 mg/kg/day over 1 generation resulted in an increased number of stillborn pups. A dose of 0.015 mg/kg/day in that study did not result in significant reproductive effects. Based on that study:
The P_4 NOAEL TRV for mammals is 0.015 mg/kg/day and
The P_4 LOAEL TRV for mammals is 0.075 mg/kg/day.

No appropriate studies on the effects of P_4 to soil invertebrates or terrestrial plants were found.

Colored Smokes

Colored smoke grenades contain a combination of colored smoke mixtures and pyrotechnic mixtures. The dye components of the colored smoke grenades (approxi-

mately 42 percent) represent the bulk of the chemicals in the mixture (NRC 1999). Most of the dyes contain anthraquinone and/or one of its derivatives. It is soluble in alcohol, ether, and acetone, and insoluble in water.

There are several inhalation studies of colored smokes, but the literature survey identified only one study that evaluated the potential for oral toxicity. Smith et al. (1986) evaluated six test articles to establish their eye and skin irritation potential and their oral and dermal toxicity. The test articles evaluated included:

Disperse Red 11 - Lot 1;
Disperse Red 11 - Lot 2;
Disperse Blue 3 - Lot 3;
Violet Mixture - 35 parts Disperse Red 11 - Lot 1:5 parts Disperse Blue 3;
Solvent Red 1; and
Red Mixture - 33.4 parts Solvent Red 1:6.6 parts Disperse Red 11 - Lot 1.

Oral studies were conducted using the Fischer-344 albino rat as the test system; all other studies used the New Zealand White Albino Rabbit as the test system. Results were as follows:

- Disperse Red 11: Lot 1 was found to be a moderate skin irritant; tested negative for eye irritation, had a dermal LD_{50} greater than 2 g/kg. The authors were unable to calculate an oral LD_{50} for males but estimate that it is between 708 and 891 mg/kg. The oral LD_{50} for females is at least 5 g/kg.
- Disperse Red 11: Lot 2 was found to be a mild skin irritant; tested negative for eye irritation, had a dermal LD_{50} greater than 2 g/kg; and oral LD_{50} of 1042.7 mg/kg in males, and greater than 5 g/kg in females.
- Disperse Blue 3: Lot 3 was found to be practically non-irritating to the skin; tested negative for eye irritation; had a dermal LD_{50} greater than 2 g/kg; and an oral LD_{50} greater than 5 g/kg.
- Violet Mixture: 35 parts Lot 1 Disperse Red 11 to 5 parts Disperse Blue 3 was found to be a mild skin irritant; tested negative for eye irritation; had a dermal LD_{50} greater than 2 g/kg; and an oral LD_{50} of between 794 and 1000 mg/kg for males, between 1,413 and 1,778 mg/kg for females, and 1052 mg/kg for combined sexes.
- Solvent Red 1: This was found to be non-irritating to the skin; tested positive for eye irritation; had a dermal LD_{50} greater than 2 g/kg; and an oral LD_{50} greater than 5 g/kg.
- Red Mixture: 33.4 parts Solvent Red 1 to 6.6 parts Lot 1 Disperse Red 11was found to be nonirritating to the skin; tested positive for eye irritation; had a dermal LD_{50} greater than 2 g/kg; and an oral LD_{50} greater than 5 g/kg.

For this analysis, only data for solvent yellow was deemed adequate for deriving TRVs. The TRVs for mammals are:
Solvent yellow chronic NOAEL = 1.36 mg/kg/day.
Solvent yellow chronic LOAEL = 13.6 mg/kg/day.

Data are insufficient for deriving TRVs for soil invertebrates, plants, birds, and reptiles and amphibians.

Terephelatic Acid

Terephthalic acid (TA), a smoke obscurant, is not particularly toxic to rodents via inhalation (Muse et al. 1997). Few studies have examined the effects of TA when administered orally to rodents. Moffitt et al. (1975) dosed adult male rats with TA by gavage. No effects were observed at the highest, single oral dose tested (80 mg TA). The body weight adjusted TRV was calculated as follows:
Given a body weight of 225 g,
Acute Dose = 80 mg/0.225 kg/day = 356 mg/kg/day,
Chronic Dose = 356 mg/kg/day divided by 100 = 35.6 mg/kg/day.

Based on this study:
The TA NOAEL TRV for mammals is 3.56 mg/kg/day.
The TA LOAEL TRV for mammals is unavailable.

Kim et al. (2001) demonstrated that TA is toxic to terrestrial plants. A reduction of radish seed germination by 30 percent occurred at a TA concentration of 1 percent in deionized water. A TRV based on solution concentration could be developed from this study. However, a soil-based TRV is desired and such a value cannot be estimated from this study.

No appropriate studies on the effects of terephthalic acid to soil invertebrates, birds, or terrestrial plants were found.

Graphite Flakes

Data are insufficient for deriving TRVs for any of the receptors.

Titanium Dioxide

Data are insufficient for deriving TRVs for any of the receptors.

Polyethylene Glycol

Data are insufficient for deriving TRVs for any of the receptors.

(o-Chlorbenzol)malononitrile (CS)

Data are insufficient for deriving TRVs for any of the receptors.

Dibenz(bf)-14-oxazepine (CR)

Researchers found two studies that evaluated the oral toxicity of dibenzo(b,f)-1,4-oxazepine to rodents: Ballantyne (1977) and Upshall (1974). Ballantyne (1977) fed mice, rats, guinea pigs, and rabbits CR via oral gavage for 5 days. No acute effects were observed in any of the test species. The highest oral dose tested in adult male guinea pigs was (63 mg CR/mg/day). The exposure period (5 days) used in this study is not considered to be a chronic exposure period. Therefore, the no-effect dose (63 mg/kg/day) was divided by a subchronic to chronic factor of 10 resulting in a NOAEL TRV of 6.3 mg/kg/day. Upshall (1974) administered CR to adult female rats via oral gavage during 1 day of pregnancy. No reproductive effects (e.g., teratogenic and embryolethal effects) were observed at the highest dose tested (400 mg/kg/day). No subchronic to chronic factor is applied because the dose was administered during a sensitive life stage. Based on these studies:
The CR NOAEL TRV for mammals is 400 mg/kg/day.
The CR LOAEL TRV for mammals is unavailable.

No appropriate studies on the effects of CR to soil invertebrates, birds, or terrestrial plants were found.

1,3,5-Trinitrobenzene (1,3,5-TNB)

1,3,5-trinitrobenzene is formed as a by-product during the manufacture of TNT. It is present in the final TNT product at concentrations ranging from 0.1 to 0.7 percent (Talmage et al. 1999) and is also formed in the environment via photolysis of TNT.

Little toxicological information was found for TNB. Quantitative Structure-Activity Relationship (QSAR) studies have found that the toxicity of nitroaromatic compounds is related to the number of constituents and their relative positions, indicating that TNB will be more toxic than other nitroaromatics (Deneer et al. 1989, Gough et al. 1994, Schmitt et al. 2000). Indigenous soil microbial communities exhibited negative correlations of basal respiration rates and phospholipid fatty acid production when exposed to TNB (Fuller and Manning 1998). TNB was found to be

mutagenic using the Salmonella fluctuation test (FT) and the V79 Chinese hamster lung cell mutagenicity assay (Lachance et al. 1999).

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) (2001a) developed a wildlife toxicity assessment to determine the adequacy of data for deriving toxicity reference values for wildlife receptors. That report identified no data for avian, reptile, and amphibian receptors. There are apparently few studies for mammals. File data from a study in which male and female rats in the high-dose group showed decreased body weights which in turn were associated with decreased food consumption, changes in relative organ weights, adverse hematological findings, and testicular effects. TRVs based on effects to mammals are:
Chronic NOAEL = 2.64 mg/kg-day.
Chronic LOAEL = 13.44 mg/kg-day.

1,3-Dinitrobenzene (1,3-DNB)

1,3-dinitrobenzene is used in the manufacture of explosives and is found as an impurity in the final product. It is formed in the environment by photolysis of 2,4-dinitrotoluene, itself a by-product of the manufacture of TNT.

Little data was found for the toxicity of DNB. QSAR studies have found that the toxicity of nitroaromatic compounds is related to the number of constituents and their relative positions, indicating that DNB will be more toxic than other mono-nitroaromatics (Deneer et al. 1989, Gough et al. 1994, Schmitt et al. 2000).

DNB is a known Sertoli cell toxicant (Allenby et al. 1990, Cave and Foster 1990). Cave and Foster (1990) concluded that DNB requires metabolic activation before it can exert its toxicity to Sertoli cells.

USACHPPM (2001b) developed a wildlife toxicity assessment to determine the adequacy of data for deriving toxicity reference values for wildlife receptors. That report identified no data for avian, reptile, and amphibian receptors. There are three subchronic studies available lasting 84 to 112 days. Testicular degeneration, an endpoint relevant to the survival of the population, was found to be the relevant endpoint (Talmage et al. 1999). TRVs for mammals are:
Chronic NOAEL = 0.113 mg/kg-day.
Chronic LOAEL = 0.264 mg/kg-day.

2,4-Dinitrophenol (2,4-DNP)

2,4-dinitrophenol is found in explosives as an impurity and can be formed in the environment.

No studies were found evaluating the effects of 2,4-dinitrophenol in plants, soil invertebrates, birds, or reptiles and amphibians.

Haghighi et al. (1995) examined the toxic effects of nitrophenols on acetate enrichment, methanogenic systems and determined that toxicity decreases in the following order: 2,4-dinitrophenol > 4-nitrophenol > 2-nitrophenol > 3-nitrophenol. Uberoi and Bhattacharya (1997) confirmed these findings when examining the toxic effects and degradability of nitrophenols in anaerobic acetate and propionate enrichment systems. The toxicity to both systems decreased in the following order: 2,4-dinitrophenol > 4-nitrophenol > 2-nitrophenol. Furthermore, Uberoi and Bhattacharya (1997) found that under anaerobic conditions 2,4-dinitrophenol was transformed both abiotically and biotically to 2-amino, 4-nitrophenol.

LD_{50} values for animals treated once with 2,4-dinitrophenol by gavage were 30 mg/kg for white rats, 71 mg/kg for weanling male rats, and 72 mg/kg for weanling male CFl mice. In a fairly reliable study on mature rats of each sex treated once by gavage, a dose-related increase in mortality was observed, with no mortality at doses of l0 to 27 mg/kg, 37 percent mortality at 30 mg/kg, and 100 percent mortality at 100 mg/kg. A 100 percent survival dose of 20 mg/kg and a 100 percent lethal dose of 60 mg/kg were reported for white rats treated once by gavage. A 100 percent survival dose of 20 mg/kg and a 100 percent lethal dose of 30 mg/kg were reported in dogs treated once by gavage.

These data are inadequate for developing TRVs for any receptor.

Dinitrotoluene isomers

2,4-DNT and 2,6-DNT are pale yellow solids with a slight odor and are two of the six forms of the chemical called dinitrotoluene (DNT). The other four forms (2,3-DNT, 2,5-DNT, 3,4-DNT, and 3,5-DNT) only make up about 5 percent of the technical grade DNT. DNT is not a natural substance but rather is usually made by reacting toluene (a solvent) with mixed nitric and sulfuric acids, which are strong acids. DNT is used to produce ammunition and explosives and to make dyes.

No studies were found for soil invertebrates, plants, birds, or reptiles and amphibians.

Several chronic feeding studies with rats have found effects ranging from testicular atrophy for 2,4-DNT and reduced weight gain (ATSDR 1998). TRVs for mammals for 2,4-DNT are:
Chronic NOAEL = 0.06 mg/kg/d.
Chronic LOAEL = 0.6 mg/kg/d.

TRVs for mammals for the remaining dinitrotoluene isomers (treated as 2,6-DNT) are:
Chronic NOAEL = 0.7 mg/kg/d.
Chronic LOAEL = 7 mg/kg-d.

Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)

Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) is formed by the nitration of hexamine with ammonium nitrate and nitric acid in an acetic acid/acetic anhydride solvent at 44^o C (ATSDR 1997). HMX is used as a component in plastic-bonded explosives, a solid fuel rocket propellant, and a burster charge for military munitions (ATSDR 1997). HMX is used to implode fissionable material in nuclear devices to achieve critical mass (ATSDR 1997).

Data are insufficient to derive TRVs for soil invertebrates, plants, birds, or reptiles and amphibians.

Everett and Maddock (1985) conducted an ingestion study in B6C3F1 mice and found significant mortality in all dose groups. However, no clinical signs of toxicity and no significant changes in body weight or clinical chemistry were noted. Based on this study, TRVs for the mammals are:
Chronic NOAEL = 3 mg/kg-day.
Chronic LOAEL = 7.5 mg/kg-day.

Nitrobenzene (NB)

Nitrobenzene is found in explosives as an impurity and can be formed in the environment.

No studies were found evaluating the effects of nitrobenzene in plants, soil invertebrates, birds, or reptiles and amphibians.

A chronic feeding study in rats found significant testicular atrophy (Bond et al. 1981). The TRVs for mammals are:
Chronic NOAEL = 1.16 mg/kg-day.
Chronic LOAEL = 5.8 mg/kg-day.

Nitroglycerin (NG)

Nitroglycerin is produced as a propellant for explosives.

Chronic exposure of laboratory animals to high NG concentrations resulted in adverse hematological and liver changes, and decreased body weight gain. Hepatocellular carcinomas as neoplastic nodules, and interstitial cell tumors of the testes were frequently observed in the high-dose group rats after 2-year exposures to NG (Ellis et al. 1978 and Ellis et al. 1984 in: USACHPPM 2001c). Four groups of 38 male and 38 female Charles River CD albino rats were fed diets containing 0, 0.01, 0.1 or 1 percent (average intakes of 0, 3.04 and 3.99, 31.5 and 38.1; 363 and 436 mg/kg/day in males and females, respectively) NG in their diet for 2 years (Ellis et al. 1978 and Ellis et al. 1984 in: USACHPPM, 2001c). No adverse effects were observed in any of the low dose rats. Mid-dose rats exhibited decreased weight gain in later months; males and females were about 60 and 30 g lighter than controls, respectively. Some rats fed 0.1 percent NG (31.0 [males] or 38.1 [females] mg/kg/day) had mild hepatic lesions (areas or foci of hepatocellular alteration that can develop into hepatocellular carcinomas). High-dose rats had decreased food consumption and weight gain, behavioral effects (decreased activity and failure to groom) compensated anemia with reticulocytosis, elevated serum transaminases, and methemoglobinemia, with some excessive pigmentatio, in the spleens and renal epithelium. After 1 year, 8 high-dose rats had cholangiofibrosis and some had neoplastic foci in the liver. At 2 years, all 13 surviving high-dose rats and 6 out of 16 middle–dose rats had enlarged and grossly abnormal livers with severe cholangiofibrosis and hepatocellular carcinomas, some of which had metastasized to the lung. Interstitial tumors of the testes were observed in one-half the high-dose males, in some leading to aspermatogenesis. A decrease in the naturally occurring pituitary chromophobe adenoma and mammary tumors increased the life-span, especially in the females (Dacre et al. 1980 and Ellis et al. 1978 and Ellis et al. 1984, in:USACHPPM 2000c). The identified NOAEL for this study was 3.04 and 3.99 mg/kg/day and the LOAEL was 31.5 and 38.1 mg/kg/day for decreased weight gain and enlarged, abnormal livers with cholangiofibrosis and hepatocellular carcinomas in males and females, respectively.

TRVs for mammals are:
Chronic NOAEL = 3 mg/kg/d.
Chronic LOAEL = 31.5 mg/kg/d.

No studies were found for soil invertebrates, plants, birds, or reptiles and amphibians.

Nitrophenol isomers

2-Nitrophenol is produced by the catalytic hydrolysis of 2-nitrochlorobenzene with NaOH. Alternatively, 2-nitrophenol can be produced by the action of dilute HNO_3 on phenol with subsequent steam distillation for separation from 4-nitrophenol. 4-Nitrophenol can also be produced in one of two ways. Like 2-nitrophneol, it can be produced by the catalytic hydrolysis of 4-nitrochlorobenzene or, alternatively, by the reaction of dilute HNO_3 on phenol and subsequent steam distillation to separate the 4- from the 2- isomer.

Nitrophenols may be released into the environment during their use as intermediates and indicators. 2-Nitrophenol is used as an intermediate for the production of dyestuffs, pigments, rubber chemicals, and fungicides. It is used in small amounts as an acid-base indicator and as a reagent for glucose. 4-Nitrophenol is used for the production of marathion, methyl parathion, and N-acetyl-p-aminophenol. 4-Nitrophenol is also used in the parathion-containing insecticide, Thiophos, and in fungicide for military footwear. Also, both 2- and 4- isomers may be released in vehicular exhaust from both gasoline and diesel engines.

There are no chronic toxicity tests available for mammals (ATSDR 1992) but there are subchronic oral studies in laboratory rats and mice. The literature summary did not identify any toxicity information for avian receptors, reptiles and amphibians, or higher order mammalian receptors. Therefore, the database is inadequate for developing toxicity reference values for ecological receptors.

Pentaerythritol Tetranitrate (PETN)

Pentaerythritol tetranitrate (PETN) is an explosive chemical that is currently used as the primary ingredient in detonating fuses and as a component (mixed with hexahydro-1,2,5-trinitro-1,3,4 triazine) in “plastic” explosives such as Semtex. Structurally, PETN resembles nitroglyerin, a compound whose pharmacological as well as explosive properties it shares.

The suite of studies reported by NTP (1989) as cited in USACHPPM (2001d) appears comprehensive. The NTP (1989) report contains subacute, subchronic, and chronic study information for mice and rats. In these studies extremely high doses were generally used. However, no corroborative effects were observed in either target or magnitude of effect. For example, kidney and brain weights were increased in the high dose for female rats only in the 14-week study, yet there was no other information that suggested that adverse effects were observed relative to the kidney and brain function (i.e., histopathology results revealed no effect), nor did the chronic study show the same effects. Male rats in the high dose group in the 104-

week study showed a 2 to 9 percent lower body mass than controls, yet these effects were not seen in females or either sex in the 14-week study.

TRVs for mammals are:
Chronic NOAEL = 170 mg/kg-day.
Chronic LOAEL = 1700 mg/kg-day.

Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)

RDX is a crystalline high explosive used extensively by the military in shells, bombs, and demolition charges. It is persistent in the environment and is found in soil, surface water, sediments, and groundwater (Talmage et al. 1999).

Simini et al. (1995) performed soil toxicity testing using the cucumber at RDX concentrations of 0, 50, 100, or 200 mg/kg of soil. Biomass of plants exposed at 100 and 200 mg/kg was significantly reduced. TRVs for plants are:
Chronic NOAEL = data not available.
Chronic LOAEL = 100 mg/kg in soil.

A study involving bobwhite (Gogal et al. 2003) found decreased survival across all dose groups. The TRVs for birds are:
Chronic NOAEL = 0.223 mg/kg-day.
Chronic LOAEL = 0.263 mg/kg-day.

There are at least three chronic toxicity studies and a two-generation reproduction study on the oral toxicity of RDX in laboratory animals available. Lish et al. (1984) conducted a chronic study in mice that found reproductive effects (testicular degeneration) from which to derive a NOAEL and LOAEL. The TRVs for mammals are:
Chronic NOAEL = 7 mg/kg-day.
Chronic LOAEL = 35 mg/kg-day.

Trinitrophenylmethylnitramine (Tetryl)

Tetryl is used as a propellant or detonator charge in military explosives. Since 1973 it has been largely replaced by RDX but is still present in the environment.

Data are insufficient for deriving TRVs for soil invertebrates, birds, or reptiles and amphibians.

Fellows et al. (1992) conducted a 70-day growth study using 3 species of plants. The TRVs for plants are:
Chronic NOEC = data are insufficient.

Chronic LOEC = 25 mg/kg in soil.

Reddy et al. (1994) conducted a subchronic study using Fischer-344 laboratory rats. The endpoint was testicular effects, relevant for survivability of the population (Talmage et al. 1999). The TRVs for mammals are:
Chronic NOAEL = 1.4 mg/kg-day.
Chronic LOAEL = 6.9 mg/kg-day.

2,4,6-Trinitrotoluene (TNT)

TNT is manufactured by a continuous process in which nitric acid and oleum are used to nitrate toluene in six to eight stages. TNT is produced at munitions production sites and is used extensively in explosives.

Cataldo et al. (1989b) grew bean, wheat, and blando broom in pots with TNT at concentrations of 10, 30, or 60 mg/kg dry weight using two different soils. Plant height was reduced by greater than 50 percent in all species in both soils at 60 mg/kg; a reduction of approximately 25 percent occurred in the wheat and grass at 30 mg/kg. The TRVs for plants are:
Chronic NOEC = data insufficient.
Chronic LOEC = 30 mg/kg in soil.

Testicular atrophy was found in Sprague-Dawley rats administered TNT in the diet at doses of 0, 1, 4, 6.97, 34.7, or 160 mg/kg-day for 13 weeks. Signs of anemia and some organ weight changes occurred at the intermediate dose levels, and testicular atrophy was observed at the highest dose of 160 mg/kg-day. Since the study was subchronic, an uncertainty factor of 10 is applied to account for chronic to subchronic extrapolation. The TRVs for mammals are:
Chronic NOAEL = 1.6 mg/kg-day.
Chronic LOAEL = 16 mg/kg-day.

Table 20. Selected plant TRV values for smokes and obscurants.

Species	Exposure Media	Exposure Duration	Effect Level	Contaminant	Effective Concentration	Units	Effect Endpoint	Reference
Ponderosa Pine, shortneedle pine, sagebrush, tall fescue	deposition on leaf surface	21 days	NOEC	SGF-2 fog oil	55	ug/cm^2	none	Cataldo et al, 1989 - see table 3.13
Ponderosa Pine, shortneedle pine, sagebrush, tall fescue	deposition on leaf surface	21 days	LOEC	SGF-2 fog oil	69	ug/cm^2	5-25% necrotic spotting, chlorosis, and old growth affected in 21 days	Cataldo et al., 1989 - see Table 3.13
Tall Fescue (grass)	deposition on soil	100 days	no effect	SGF-2 fog oil	up to 330	ug/cm^2 of soil	no effect on dry matter production in first harvest	Cataldo et al., 1989 - Table 3.22
Corn, cucumber	spiked soil	14 days	no adverse effect observed	graphite flakes	50	mg/kg	growth	Phillips and Wentsel (1990)
Radish	deionized water	6 days	LOEC	terephthalic acid	1	%	seed germination	Kim et al., 2001
Black locust, black cherry	airborne foliar deposition	7 days	no adverse effect observed	HC (zinc)	0.3	ug/cm^2	none	Sadusky et al., 1993
Black locust, black cherry	airborne foliar deposition	7 days	leaf spot, chlorotic mottle	HC (zinc)	6.4	ug/cm^2	defoliation	Sadusky et al., 1993
Tall fescue, bush bean	airborne foliar deposition	7 days	no adverse effect observed	HC (zinc)	3	ug/cm^2	chlorosis, leaf burn	Battelle, 1989
Tall fescue, bush bean	airborne foliar deposition	7 days	leaf spot, chlorotic mottle	HC (zinc)	5	ug/cm^2	chlorosis, leaf burn, leaf drop	Battelle, 1989
Ponderosa Pine, bush bean, big sagebrush, shortneedle pine, tall fescue	airborne foliar deposition	30 days	NOEC	brass flakes	237.01	ug/cm2 (foliar mass loading)	effects on old and new growth	Cataldo et al. (1990)
Ponderosa Pine, bush bean, big sagebrush, shortneedle pine, tall fescue	airborne foliar deposition	60 days	LOEC	brass flakes	238.68	ug/cm2 (foliar mass loading)	significant reduction in dry matter production	Cataldo et al. (1990)

Species	Exposure Media	Exposure Duration	Effect Level	Contaminant	Effective Concentration	Units	Effect Endpoint	Reference
Bush bean (*Phaseolus vulgaris*), alfalfa, Tall Fescue (*Festuca elator*)	four soil types at various stages of weathering (up to 450 days of weathering)	2 weeks	no adverse effect observed	brass flake	2500	mg/kg	seed germination	Cataldo et al. (1990)
Tall fescue, bush bean	spiked soil	60 days	no adverse effect observed	brass flakes	100	ug/g	less than 25% chlorosis and necrotic spotting	Cataldo et al. (1990)
Tall Fescue, bush bean	spiked soil	60 days	effect observed	brass flakes	100	ug/g	greater than 30-40%% chlorosis, necrotic spotting, tip burn; significant difference in dry production	Cataldo et al. (1990)
Bush Bean, big sagebrush, Ponderosa pine, shortneedle pine, tall fescue	airborne foliar deposition	30 days	no adverse effect observed	brass flake/fog oil	148.68	ug/cm2 (foliar mass loading)	growth, leaf burn, leaf drop, necrotic spotting, leaf abscission or needle drop, chlorosis, dieback, leaf curl, wilting, survival. Floral/seed/fruit abortion	Cataldo et al. (1990)
Bush Bean, big sagebrush, Ponderosa pine, shortneedle pine, tall fescue	airborne foliar deposition	30 days	effect observed	brass flake/fog oil	376.65	ug/cm2 (foliar mass loading)	new growth, wilting, leaf curl, necrotic spotting	Cataldo et al. (1990)

Table 21. Selected avian TRV values for smokes and obscurants.

Compound	Chemical Form	Test Species	Exposure Route	Exposure Duration (Days)	Effect	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	Source	Note
Fog Oil	10-W and 10-W-30 lubricating oils	Duck	stomach tube	1 dose	No lethality observed in unstressed ducks	No effect observed at highest dose of 17,000 mg/kg.	No data	Hartung and Hunt, 1966.	Not enough data available to develop NOAEL and LOAEL; use for qualitative assessment only.
Hexachloroethane smoke (zinc)	zinc	White leghorn	diet	44 weeks	Reduced egg hatchability	14.5	131	Sample et al., 1996	
White phosphorus	P4	Domestic chicken	gavage in water	5	Reproduction (egg laying frequency)	0.01	0.1	Nam et al., 1996	LOAEL based on an effect dose of 1 mg/kg/day over 5 days divided by 10 to adjust subchronic to chronic dose. LOAEL/10 = NOAEL
White phosphorus	P4	American kestrel	prey (dosed chicks)	1	Mortality and weight loss	0.0062	0.062	Sparling and Federoff, 1997	LOAEL based on an effect dose of 0.62 mg/kg/day over 1 day divided by 10 to adjust subchronic to chronic dose. LOAEL/10 = NOAEL
White phosphorus	P4	Mallard	gavage in oil	7	Renal and hepatic impairement as indicated by blood tests.	0.005	0.05	Sparling et al., 1998.	LOAEL based on an effect dose of 0.5 mg/kg/day over 7 days divided by 10 to adjust subchronic to chronic dose. LOAEL/10 = NOAEL

Notes: No toxicity data available for birds for graphite flakes, brass flakes, or colored smoke constituents.

Table 22. Selected mammalian TRV values for smokes and obscurants.

Compound	Chemical Form	Test Species	Exposure Route	Exposure Duration (Days)	Effect	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	Source	Note
Fog Oil	Fog oil	Rat	Exposure route not given	Duration not given.	Mortality	No data.	50	Mayhew et al., 1986 in Driver et al., 1993.	LD50 of 5000 mg/kg used as an upper bound since a no effect level was available. LD50/100 to adjust acute to chronic dose. Note that there is great uncertainty in this value.
Fog Oil	White mineral oil	Long-Evans rat	Food	90	general health, food consumption, body weight, hematology, serum chemistry, urinalysis	12	No data.	Smith et al., 1995	No effect at hightest concentration tested of 1500 mg/kg food. Used because an LD50 value was available as an upper bound. Converted to daily dose. Adjusted by 1/10 to convert subchronic to chronic dose.
Graphite Flakes	Graphite	Rat	gavage in corn oil	Duration not given.	Acute toxicity	No effect observed at dose of 5000 mg/kg.	No data.	Manthei et al., 1980 cited in NRC, 1999	Not enough data available to develop NOAEL and LOAEL; use for qualitative assessment only.
Brass Flakes	Brass flakes	Rat	gavage in corn oil	1 dose.	Lethality	No data.	LD50 of 2,780 mg/kg	Manthei et al., 1983 cited in NRC, 1999.	Not enough data available to develop NOAEL and LOAEL; use for qualitative assessment only.
Hexachloroethane smoke (zinc)	zinc	Rat	diet	16 d (during gestation)	fetal resorption, reduced fetal growth rate	160	320	Sample et al., 1996	

Compound	Chemical Form	Test Species	Exposure Route	Exposure Duration (Days)	Effect	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	Source	Note
Solvent yellow 33	(2-quinolyl)-1,3-indandione or QID	F344/N rats	Food	14 to 91	body weight gain; increased liver weight; other liver effects	1.36	13.6	Eastin et al., 1996 cited in NRC, 1999	LOAEL based on an effect concentration 1700 mg/kg converted to a dose of 136 mg/kg/day divided by 10 to convert subchronic dose to chronic. LOAEL/10 = NOAEL
Solvent green 3	1,4-di-p-toluidino-9,10-anthraquinone (PTA)	Rat	Not reported	1 dose.	Lethality	No data.	LD50 of 3000 mg/kg	Dacre et al, 1979 in NRC, 1999	Not enough data available to develop NOAEL and LOAEL; use for qualitative assessment only.
Solvent red 1	alpha-methoxybenzenazo-beta-naphthol (MBN)	Two species of rats	Oral, but method unknown	1 dose.	Lethality	No effect at 5000 mg/kg.	No data.	Manthei et al, 1983 and Smith et al., 1986 in NRC, 1999	Not enough data available to develop NOAEL and LOAEL; use for qualitative assessment only.
Disperse red 11	1,4-diamino-2-methoxyanthraquionone (DMA)	Fischer 344 rat (male)* no effect on female rats	Oral, but method unknown	1 dose.	Lethality	No data.	LD50 of 1000 mg/kg	Smith et al., 1986 in NRC, 1999	Not enough data available to develop NOAEL and LOAEL; use for qualitative assessment only.
Terephthalic acid	TA	Adult male Charles River rats	Oral gavage	single dose	Mortality	3.56	NA	Moffitt et al., 1975	No effects were observed at the highest oral dose tested (80 mg TA) for single dose. BW = 225 g, dose = 80 mg/0.225 kg/1 day = 356 mg/kg/d divided by 100 to adjust acute to chronic dose.
Benz(b,f)-1,4-oxazepine	CR	Adult male guinea pigs	Oral gavage	5	Mortality and growth	6.3	NA	Ballantyne, 1977	No effects were observed at the highest oral dose tested (63 mg CR/kg/day) over 5 days divided by 10 to adjust subchronic to chronic dose.

Compound	Chemical Form	Test Species	Exposure Route	Exposure Duration (Days)	Effect	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	Source	Note
Benz(b,f)-1,4-oxazepine	CR	Adult female rats	Oral - intragastric administration	Single dose on Day 7 of pregnancy	Reproduction - teratogenic and embryolethal effects	400	NA	Upshall, 1974	No effects were observed at the highest oral dose tested (400 mg CR/kg/day) with a single dose during sensitive lifestage (no ACR needed).
White phosphorus	P4	Charles River COBS CD rats	Oral gavage	1 generation	reproduction - increased the number of stillborn pups	0.015	0.0175	IRDC, 1985 unpublished study cited in ATSDR, 1989	Data developed from generational study; does not require uncertainty factors.
White phosphorus	White phosphorus	Charles River COBS CD rats	Oral gavage	1 generation	reproduction - increased the number of stillborn pups	0.015	0.0175	IRDC, 1985 unpublished study cited in ATSDR, 1989	Data developed from generational study; does not require uncertainty factors.

Notes:
Solvent yellow 33 makes up 42 % of new yellow smoke formulation and 12.6% of new green smoke formulation (NRC, 1999).
It is 71.3% of fallout from yellow smoke grenade detonation and 27.3% of fallout from green smoke grenade detonation (Buchanan and Ma, 1988).
Solvent green 3 makes up 29.4% of new green smoke formulation (NRC, 1999) and 58% of green smoke grenade detonation fallout (Buchanan and Ma, 1988).
Solvent red 1 makes up 34.2% of new red smoke formulation (NRC, 1999) and 35% of red smoke grenade detonation fallout (Buchanan and Ma, 1988).
Disperse red 11 makes up 6.8% of new red smoke formulation (NRC, 1999) and 15% of fallout from red smoke grenade detonation (Buchanan and Ma, 1988).

Table 23. Selected plant TRV values for MUCs.

Compound	Accronym	NOAEL (mg/kg)	LOAEL (mg/kg)	Reference	As cited in
2,4,6-Trinitrotoluene	TNT		30	Cataldo et al., 1989	Talmage et al., 1999
1,3,5-Trinotrobenzene	TNB	Insufficient data			Talmage et al., 1999
1,3-Dinitrobenzene	DNB	Insufficient data			Talmage et al., 1999
3,5-dinitronaline	DNA		Insufficient data		Talmage et al., 1999
2-amino-4,6-dinitrotoluene	2-DANT	80		Pennington 1988a,b	Talmage et al., 1999
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX		100	Simini et al., 1992	Talmage et al., 1999
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	Insufficient data			Talmage et al., 1999
N-methyl-N,2,4,6-tetranitroaniline	Tetryl		25	Fellows et al., 1992	Talmage et al., 1999

Table 24. Selected avian TRV values for MUCs.

Compound	Acronym	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Test Organism	Effect/ Endpoint	Reference	As cited in
2,4,6-Trinitrotoluene	TNT	0.7	17.8	northern bobwhite	survival	Gogal et al., 2002	
1,3,5-Trinotrobenzene	TNB	Insufficient data					Talmage et al., 1999
1,3-Dinitrobenzene	DNB	Insufficient data					Talmage et al., 1999
3,5-Dinitroanaline	DNA	Insufficient data					Talmage et al., 1999
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	2.23	2.63	northern bobwhite	survival	Gogal et al., 2003	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	Insufficient data					
N-methyl-N,2,4,6-tetranitroaniline	Tetryl	Insufficient data					
Note: TRVs for TNT and RDX based on subchronic studies. Reported NOAEL and LOAEL divided by 10 to estimate chronic TRV.							

Table 25. Selected mammalian TRV values for MUCs.

Compound	Acronym	NOAEL (mg/kg/day)	LOAEL (mg/kg/day)	Test Organism	Body Weight (kg)	Effect/ Endpoint	Reference	As cited in
2,4,6-Trinitrotoluene	TNT	1.6	16	rat	0.289	Testicular atrophy	Dilley et al., 1982	Talmage et al., 1999
1,3,5-Trinotrobenzene	TNB		13.44	rat	0.35	Decreased body weight	Reddy et al., 1996	Talmage et al., 1999
1,3-Dinitrobenzene	DNB	0.113	0.264	rat	0.35	Testicular degeneration	Cody et al., 1981	Talmage et al., 1999
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	7	35	mouse	0.0359	Testicular degeneration	Lish et al., 1984	Talmage et al., 1999
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	3	7.5	mouse	0.025	Mortality	Everett and Maddock, 1985	Talmage et al., 1999
N-methyl-N,2,4,6-tetranitroaniline	tetryl	1.4	6.9	rat	0.258 (males)	Reduced body weight (females)	Reddy et al., 1994c	Talmage et al., 1999
Pentaerythritol Tetranitrate	PETN	170	1700	rat	0.35 (estimate)	Reduced body weight	Bucher et al., 1990	USCHPPM, 2001
2,4-Dinitrotoluene	2,4-DNT	0.06	0.6	rat	0.35 (estimate)	Testicular atrophy	Lee et al., 1978, 1985, Ellis et al., 1979	ATSDR, Dec 1998
2,6-Dinitrotoluene	2,6-DNT	0.7	7	rat	0.35 (estimate)	Reduced body weight (males)	Leonard et al., 1987	ATSDR, Dec 1998
Nitroglycerin	NG	3	32	rat	0.35 (estimate)	Reduced body weight	Ellis et al., 1978	USA CHPPM, 2001
Nitrobenzene	NB	1.16	5.8	rat	0.58	Testicular atrophy	Cattley et al., 1994	

6 Risk Characterization

The risk characterization provides exposure and toxicity quotient estimates for each installation. Exposure estimates are derived following the methodology described in Chapter 4. Exposure or dose estimates are divided by applicable TRVs discussed in Chapter 5 and presented in Tables 20 through 25 to obtain toxicity quotients. The equation is given as:

$$TQ = \frac{Dose_{receptor}}{TRV} \qquad \text{[Equation 8]}$$

where:

TQ = Toxicity Quotient
$Dose_{receptor}$ = Predicted dose to the receptor (mg/kg/day)
TRV = toxicity reference value (mg/kg/day).

In general, estimated TQs greater than one are considered indicative of potential adverse effects to threatened and endangered species of concern. TQs are estimated using TRVs derived from both NOAELs and LOAELs, where available. A potential for risk is interpreted as high, moderate, or low, depending on whether the TRVs exceeded a NOAEL and/or a LOAEL, and depending on the assumed dud rate, as follows:

Exceeds the	Compared to 10% dud rate	Compared to 100% dud rate
NOAEL	moderate	low
LOAEL	high	moderate

The NOAEL is the dose or concentration at which no effect is observed, while the LOAEL is the lowest dose or concentration at which an effect is observed. The true effect level is unknown but lies somewhere between the NOAEL and LOAEL. Therefore, both comparisons are relevant to a determination of potential risk.

Tables 26 through 40 present results of exposure and risk estimates for each installation and TES of concern. These results are discussed in the following paragraphs.

Fort Rucker, Alabama

Table 26 provides the exposure and toxicity quotient estimates for Fort Rucker. There are no exceedances of any TRVs for Fort Rucker, and predicted toxicity quotients are below 1. Therefore, potential risk to TES of concern from exposure to COCs for which toxicity data are available is low. This screening level assessment assumes that the entire mass of COCs found in munitions is deposited over the impact area (22 mi^2).

Yuma Proving Ground, Arizona

There are no data for Yuma Proving Ground.

Fort Irwin, California

Table 27 provides the exposure and toxicity quotient estimates for Fort Irwin. There are no exceedances of any TRVs. Potential risk to threatened and endangered species of concern from exposure to COCs for which toxicity data are available is low. This assessment assumes that the entire mass of COCs found in munitions is deposited over the impact area (159 mi^2).

Fort Benning, Georgia

Table 28 provides the exposure and toxicity quotient estimates for Fort Benning. Predicted toxicity quotients for the red-cockaded woodpecker exceed 1 for white phosphorus on an NOAEL basis but not for the LOAEL. Both the NOAELs and LOAELs are exceeded for potential effects on vegetation from fog oil. Assuming a 10 percent dud rate for the munitions results in no exceedances. However, assuming that the entire mass of COCs in munitions is deposited over the impact area (25 mi^2), results in a NOAEL-based TQ greater than 1 for exposure to TNT and RDX, and an LOAEL-based TQ greater than 1 for exposure to RDX. There is the moderate potential for risk to the red-cockaded woodpecker from exposure to white phosphorus and RDX and a high potential for risk to vegetation from exposure to fog oil. There is a low potential for risk to the red-cockaded woodpecker from exposure to RDX.

Fort Gordon, Georgia

Table 29 provides the exposure and toxicity quotient estimates for Fort Gordon. There are no exceedances of any TRVs. Potential risk to threatened and endangered species of concern from exposure to COCs for which toxicity data are available is low. This analysis assumes that the entire mass of COCs found in munitions is deposited over the impact area (19 mi^2).

Fort Stewart, Georgia

Table 30 provides the exposure and toxicity quotient estimates for Fort Stewart. There is potential for adverse effects to red-cockaded woodpecker from exposure to white phosphorus smoke. Assuming a 10 percent dud rate for munitions results in potential adverse effects to the red-cockaded woodpecker from exposure to TNT on a NOAEL basis. Assuming the entire mass of COCs in munitions is deposited over the impact area (30 mi^2) results in potential adverse effects to the red-cockaded woodpecker from exposure to RDX and TNT. There is a high potential for risk to the red-cockaded woodpecker from exposure to white phosphorus. There is a moderate potential for risk to the red-cockaded woodpecker from exposure to RDX and TNT.

Fort Campbell, Kentucky

Table 31 provides the exposure and toxicity quotient estimates for Fort Campbell. There is potential for adverse effects to the Indiana bat and gray bat from exposure to white phosphorus smoke. Assuming that the entire mass of COCs in the munitions (100 percent dud rate) is deposited over the impact area (39 mi^2) results in potential adverse effects to the Indiana and gray bats from exposure to RDX, TNT, nitroglycerin, and 1,3-dinitrobenzene on an NOAEL basis and 1,3-dinitrobenzene on an LOAEL basis. Therefore, there is a moderate potential for risk for these chemicals and a high potential for risk from white phosphorus.

Fort Knox, Kentucky

Table 32 provides the exposure and toxicity quotient estimates for Fort Knox. There is a low potential for adverse effects to Indiana bat and gray bat from exposure to fog oil smoke based on an exceedance of the NOAEL but not the LOAEL. All other TQ estimates are below 1. This analysis assumes that the entire mass of COCs found in munitions is deposited over the impact area (158 mi^2).

Fort Polk, Louisiana

Table 33 provides the exposure and toxicity quotient estimates for Fort Polk. There is a high potential for adverse effects to the red-cockaded woodpecker from exposure to white phosphorus smoke. Assuming either a 10 percent or 100 percent dud rate results in potential adverse effects to the red-cockaded woodpecker from exposure to TNT and RDX.

Camp Shelby, Mississippi

Table 33 provides the exposure and toxicity quotient estimates for Camp Shelby. There is potential for adverse effects to the red-cockaded woodpecker from exposure to white phosphorus smoke based on exceedances of both the NOAEL and LOAEL, and from fog oil to vegetation. The dose of fog oil estimated for the gopher tortoise exceeds the NOAEL, but not the LOAEL, suggesting a moderate potential for adverse effects. Assuming a 10 percent dud munitions rate shows there is potential for adverse effects to the red-cockaded woodpecker from exposure to TNT on a NOAEL basis. Assuming the entire mass of COCs is deposited over the impact area (12 mi^2) increases potential risk from TNT and RDX. (The potential risks to the red-cockaded woodpecker assumes that the species is present on Camp Shelby).

Fort Leonard Wood, Missouri

Table 35 provides the exposure and toxicity quotient estimates for Fort Leonard Wood. For the Indiana and gray bat, NOAEL-based TQs exceed 1 from exposure to 1,3-trinitrobenzene and LOAEL- and NOAEL-based TQs exceed 1 from exposure to 1,3=dinitrobenzene, RDX, and TNT. This suggests a potential risk to the bats if only 10 percent of munitions are distributed throughout the impact area (0.79 mi^2). Assuming deposition of 100 percent of the munitions increases the potential risk from terephthalic acid, PETN, and nitroglycerin on a NOAEL basis. For vegetation, there are no exceedances assuming a 10 percent dud rate but there are exceedances for RDX and TNT assuming a 100 percent dud rate. There is also a high potential for risk to both the Indiana and gray bats as well as vegetation from exposure to fog oil.

Fort Bragg, North Carolina

Table 36 provides the exposure and toxicity quotient estimates for Fort Bragg. There is potential for adverse effects to red-cockaded woodpecker from exposure to

white phosphorus smoke. Assuming a 10 percent dud rate for munitions results in potential adverse effects to red-cockaded woodpecker from exposure to RDX and TNT, suggesting potential risk to the woodpecker from exposure to RDX and possibly TNT. Assuming the entire mass of COCs in munitions is deposited over the impact area (51 mi^2) further increases potential risk for those two chemicals.

Fort Sill, Oklahoma

Table 37 provides the exposure and toxicity quotient estimates for Fort Sill. Assuming 100 percent of the COCs in munitions are deposited over the impact area (73 mi^2) results in no exceedances of any TRVs.

Fort Jackson, South Carolina

Table 38 provides the exposure and toxicity quotient estimates for Fort Jackson. Assuming 10 percent of COCs in munitions are deposited over the impact area (17 mi^2) results in no exceedances of TRVs. Assuming 100 percent of COCs in munitions are deposited over the impact area results in an exceedance of the NOAEL-based TQ above 1 from exposure to TNT and RDX and an exceedance of the LOAEL for RDX. This suggests a moderate potential risk to the red-cockaded woodpecker from exposure to munitions. There is a high potential for risk to the red-cockaded woodpecker from exposure to white phosphorus and to vegetation from exposure to fog oil.

Camp Bullis, Texas

Table 39 provides the exposure and toxicity quotient estimates for Camp Bullis. Assuming 100 percent of COCs in munitions are deposited over the impact area (43 mi^2) results in no exceedances.

Fort Hood, Texas

Table 40 provides the exposure and toxicity quotient estimates for Fort Hood. Assuming 10 percentof COCs in munitions are deposited over the impact area (34 mi^2) results in an exceedance of NOAEL-based TQs above 1 for both the black-capped vireo and the golden-cheeked warbler from exposure to TNT. Potential risk is further increased assuming 100 percent of COCs in munitions are deposited over the impact area for both TNT and RDX. There is a high potential for risk to the birds from exposure to white phosphorus and to vegetation from exposure to fog oil.

Table 26. Exposure and risk estimates for Fort Rucker, Alabama.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww
Smokes and Obscurants				
Fog Oil Smoke				
Hexachloroethane (HC) Smoke	3.74			
White Phosphorous (WP) Smoke	3.08			
Brass Flakes	-0.52			
Graphite Flakes				
Titanium Dioxide	2.23			
Polyethylene Glycol (PEG)	-1.2			
Terephthalic Acid	2	1421.81	1.88E-04	1.00E-04
(o-Chlorbenzol)malononitrile (CS)	2.76	17.63	2.34E-06	4.51E-07
Dibenz(bf)-14-oxazepine (CR)	3.49			
Colored Smokes				
CI Basic Yellow 2	3.54			
Disperse Yellow 11	4.54	149.05	1.97E-05	3.54E-07
Disperse Red 9	4.045	51328.05	6.80E-03	2.36E-04
Solvent Green 3	8.995	49816.06	6.60E-03	3.08E-07
Solvent Yellow 33	4.1	49928.20	6.61E-03	2.13E-04
Yellow Smoke 6	6.28			
Dye Yellow 4 (Benzanthrone)	4.81			
Military Unique Compounds				
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	25722.11	3.41E+00	6.04E+00
1,3-Dinitrobenzene (1,3-DNB)	1.49	25722.11	3.41E+00	3.59E+00
2,4 - Dinitrophenol (2,4-DNP)	1.67			
Dinitrotoluene isomers	2.14	49250.52	6.52E-03	2.88E-03
2,4-Dinitrotoluene	1.98			

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	2617.10	3.47E-04	2.16E-03
Nitrobenzene (NB)	1.85			
Nitroglycerin (NG)	1.62	56836138.54	7.53E+00	6.66E+00
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9			
Pentaerythritol Tetranitrate (PETN)	1.61	1006.98	1.33E-04	1.20E-04
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	435989.39	5.78E-02	1.39E-01
Trinitrophenylmethylnitramine (Tetryl)	2.4	27913.15	3.70E-03	1.15E-03
2,4,6-Trinitrotoluene (TNT)	1.6	257221.11	3.41E-02	3.10E-02

Table 26 Continued.

Compound	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww
Smokes and Obscurants				
Fog Oil Smoke	NA			
Hexachloroethane (HC) Smoke	NA			
White Phosphorous (WP) Smoke	NA			
Brass Flakes	NA			
Graphite Flakes	NA			
Titanium Dioxide				
Polyethylene Glycol (PEG)				
Terephthalic Acid				
(o-Chlorbenzol)malononitrile (CS)				
Dibenz(bf)-14-oxazepine (CR)				

Compound	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww
Colored Smokes				
CI Basic Yellow 2				
Disperse Yellow 11				
Disperse Red 9				
Solvent Green 3				
Solvent Yellow 33				
Yellow Smoke 6				
Dye Yellow 4 (Benzanthrone)				
Military Unique Compounds				
1,3,5-Trinitrobenzene (1,3,5-TNB)				
1,3-Dinitrobenzene (1,3-DNB)				
2,4 - Dinitrophenol (2,4-DNP)				
Dinitrotoluene isomers				
2,4-Dinitrotoluene				
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)				
Nitrobenzene (NB)				
Nitroglycerin (NG)				
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)				
Pentaerythritol Tetranitrate (PETN)				
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)				
Trinitrophenylmethylnitramine (Tetryl)				
2,4,6-Trinitrotoluene (TNT)				

Table 26 Continued

Compound	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Tortoise	LOAEL-based TQ for Tortoise
Smokes and Obscurants						
Fog Oil Smoke						
Hexachloroethane (HC) Smoke						
White Phosphorous (WP) Smoke						
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						
Polyethylene Glycol (PEG)						
Terephthalic Acid		6.11E-04	5.99E-07			
(o-Chlorbenzol)malononitrile (CS)		2.75E-06	2.69E-09			
Dibenz(bf)-14-oxazepine (CR)						
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11		2.15E-06	2.11E-09			
Disperse Red 9		1.44E-03	1.41E-06			
Solvent Green 3		1.88E-06	1.84E-09			
Solvent Yellow 33		1.30E-03	1.27E-06		9.36E-06	9.36E-07
Yellow Smoke 6						
Dye Yellow 4 (Benzanthrone)						
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)						
1,3-Dinitrobenzene (1,3-DNB)						
2,4 - Dinitrophenol (2,4-DNP)						

Compound	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Tortoise	LOAEL-based TQ for Tortoise
Dinitrotoluene isomers		1.76E-02	1.72E-05			
2,4-Dinitrotoluene						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)		1.31E-02	1.29E-05		4.29E-05	1.72E-05
Nitrobenzene (NB)			0.00E+00			
Nitroglycerin (NG)		4.06E+01	3.98E-02			
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)			0.00E+00			
Pentaerythritol Tetranitrate (PETN)		7.28E-04	7.14E-07		4.20E-08	4.20E-09
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		8.47E-01	8.31E-04	1.39E-03	1.19E-03	2.37E-04
Trinitrophenylmethylnitramine (Tetryl)		7.03E-03	6.89E-06	4.62E-05		
2,4,6-Trinitrotoluene (TNT)		1.89E-01	1.85E-04	1.03E-03	1.16E-03	1.16E-04

1. Concentration in aquatic insects estimated via equilibrium partitioning with sediment.
2. Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 27. Exposure and risk estimates for Fort Irwin, California.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
Smokes and Obscurants							
Fog Oil Smoke					5.50E+01	7.23E+00	1.92E+01
Hexachloroethane (HC) Smoke	3.74	6558519.06	1.20E-01	6.27E-03			
White Phosphorous (WP) Smoke	3.08	11415028.93	2.09E-01	2.63E-02			
Brass Flakes	-0.52				NA		
Graphite Flakes					NA		
Titanium Dioxide	2.23						
Polyethylene Glycol (PEG)	-1.2						
Terephthalic Acid	2	1196451.42	2.19E-02	1.17E-02			
(o-Chlorbenzol)malononitrile (CS)	2.76	35662.62	6.54E-04	1.26E-04			
Dibenz(bf)-14-oxazepine (CR)	3.49						
Colored Smokes							
CI Basic Yellow 2	3.54						
Disperse Yellow 11	4.54						
Disperse Red 9	4.045	169869.79	3.11E-03	1.08E-04			
Solvent Green 3	8.995	208208.05	3.82E-03	1.78E-07			
Solvent Yellow 33	4.1	155922.87	2.86E-03	9.22E-05			
Yellow Smoke 6	6.28						
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1						
1,3-Dinitrobenzene (1,3-DNB)	1.49						

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
2,4 - Dinitrophenol (2,4-DNP)	1.67						
Dinitrotoluene isomers	2.14	15054908.03	2.76E-01	1.22E-01			
2,4-Dinitrotoluene	1.98						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	16985.25	3.11E-04	1.94E-03			
Nitrobenzene (NB)	1.85						
Nitroglycerin (NG)	1.62	2899893.79	5.31E-02	4.70E-02			
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9						
Pentaerythritol Tetranitrate (PETN)	1.61	1216037.57	2.23E-02	2.00E-02			
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	38977386.84	7.14E-01	1.72E+00			
Trinitrophenylmethylnitramine (Tetryl)	2.4	40760.92	7.47E-04	2.33E-04			
2,4,6-Trinitrotoluene (TNT)	1.6	128834262.56	2.36E+00	2.15E+00			

Table 27 Continued.

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves ug/cm^2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Desert Tortoise mg/kg-day
Smokes and Obscurants					
Fog Oil Smoke	1.28E+01	1.92E+01	1.47E+01	7.78E+01	7.81E-02
Hexachloroethane (HC) Smoke				3.82E-02	2.56E-05
White Phosphorous (WP) Smoke				1.60E-01	1.07E-04
Brass Flakes					

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves ug/cm^2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Desert Tortoise mg/kg-day
Graphite Flakes					
Titanium Dioxide					
Polyethylene Glycol (PEG)					
Terephthalic Acid				7.11E-02	4.77E-05
(o-Chlorbenzol)malononitrile (CS)				7.68E-04	5.15E-07
Dibenz(bf)-14-oxazepine (CR)					
Colored Smokes					
CI Basic Yellow 2					
Disperse Yellow 11					
Disperse Red 9				6.58E-04	4.41E-07
Solvent Green 3				1.09E-06	7.27E-10
Solvent Yellow 33				5.61E-04	3.76E-07
Yellow Smoke 6					
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)					
1,3-Dinitrobenzene (1,3-DNB)					
2,4 - Dinitrophenol (2,4-DNP)					
Dinitrotoluene isomers				7.43E-01	4.97E-04
2,4-Dinitrotoluene					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)				1.18E-02	7.90E-06
Nitrobenzene (NB)					
Nitroglycerin (NG)				2.86E-01	1.92E-04
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)					

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves ug/cm^2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Desert Tortoise mg/kg-day
Pentaerythritol Tetranitrate (PETN)				1.22E-01	8.16E-05
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)				1.05E+01	7.02E-03
Trinitrophenylmethylnitramine (Tetryl)				1.42E-03	9.52E-07
2,4,6-Trinitrotoluene (TNT)				1.31E+01	8.76E-03

1. Concentration in aquatic insects estimated via equilibrium partitioning with sediment.
2. Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 27 Continued

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ forTree Leaves	NOAEL-based TQ for Desert Tortoise	LOAEL-based TQ for Desert Tortoise
Smokes and Obscurants						
Fog Oil Smoke	3.5E-01	2.8E-01	3.5E-01	2.8E-01	6.5E-02	1.6E-02
Hexachloroethane (HC) Smoke						
White Phosphorous (WP) Smoke					7.2-02	6.1E-02
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						
Polyethylene Glycol (PEG)						
Terephthalic Acid					1.3E-04	
(o-Chlorbenzol)malononitrile (CS)						
Dibenz(bf)-14-oxazepine (CR)						

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ forTree Leaves	NOAEL-based TQ for Desert Tortoise	LOAEL-based TQ for Desert Tortoise
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11						
Disperse Red 9						
Solvent Green 3						
Solvent Yellow 33					2.8-06	2.8-07
Yellow Smoke 6						
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)					6.5E-03	1.3E-03
1,3-Dinitrobenzene (1,3-DNB)					9.0E-02	3.8E-02
2,4 - Dinitrophenol (2,4-DNP)						
Dinitrotoluene isomers						
2,4-Dinitrotoluene						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					2.6E-05	1.1E05
Nitrobenzene (NB)						
Nitroglycerin (NG)					6.4E-04	6.0E-05
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)						
Pentaerythritol Tetranitrate (PETN)					4.8E-06	4.8E-07
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		1.7E-02		1.7E-02	1.0E-02	2.0E-03
Trinitrophenylmethylnitramine (Tetryl)		9.3E-06		9.3E-06		
2,4,6-Trinitrotoluene (TNT)		7.2E-02		7.2E-02	5.5E02	5.5E03

Table 28. Exposure and risk estimates for Fort Benning, Georgia.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons
Smokes and Obscurants					
Fog Oil Smoke					5.00E+02
Hexachloroethane (HC) Smoke	3.74	63009.35	7.34E-03	3.83E-04	
White Phosphorous (WP) Smoke	3.08	288846.00	3.37E-02	4.24E-03	
Brass Flakes	-0.52				NI
Graphite Flakes					NI
Titanium Dioxide	2.23				
Polyethylene Glycol (PEG)	-1.2				
Terephthalic Acid	2	710.90	8.29E-05	4.41E-05	
(o-Chlorbenzol)malononitrile (CS)	2.76	3.28	3.82E-08	7.38E-09	
Dibenz(bf)-14-oxazepine (CR)	3.49				
Colored Smokes					
CI Basic Yellow 2	3.54	21.79	2.54E-06	1.73E-07	
Disperse Yellow 11	4.54	28414.64	3.31E-03	5.93E-05	
Disperse Red 9	4.045	8420.58	9.82E-04	3.41E-05	
Solvent Green 3	8.995	533.44	6.22E-05	2.90E-09	
Solvent Yellow 33	4.1	2922.59	3.41E-04	1.10E-05	
Yellow Smoke 6	6.28	1012.37	1.18E-04	2.07E-07	
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	137943.08	1.61E-02	2.85E-02	
1,3-Dinitrobenzene (1,3-DNB)	1.49	13794.31	1.61E-03	1.69E-03	
2,4 - Dinitrophenol (2,4-DNP)	1.67				
Dinitrotoluene isomers	2.14	26259.99	3.06E-03	1.35E-03	
2,4-Dinitrotoluene	1.98	1.09	1.27E-07	6.94E-08	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	84989.90	9.91E-03	6.16E-02	

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons
Nitrobenzene (NB)	1.85				
Nitroglycerin (NG)	1.62	243269.14	2.84E-02	2.51E-02	
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9				
Pentaerythritol Tetranitrate (PETN)	1.61	70099.09	8.17E-03	7.33E-03	
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	940614.64	1.10E-01	2.64E-01	
Trinitrophenylmethylnitramine (Tetryl)	2.4	4231.81	4.93E-04	1.54E-04	
2,4,6-Trinitrotoluene (TNT)	1.6	1379430.85	1.61E-01	1.46E-01	
1 - NI indicates installation reports using fog oil or additives, but the amount used is not available					

Table 28 Continued.

Compound	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves ug/cm^2	Concentration in aquatic insects[2] mg/kg bw
Smokes and Obscurants					
Fog Oil Smoke	6.57E+01	1.74E+02	1.16E+02	1.74E+02	1.33E+02
Hexachloroethane (HC) Smoke					
White Phosphorous (WP) Smoke					
Brass Flakes					
Graphite Flakes					
Titanium Dioxide					
Polyethylene Glycol (PEG)					
Terephthalic Acid					
(o-Chlorbenzol)malononitrile (CS)					

Compound	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves ug/cm^2	Concentration in aquatic insects[2] mg/kg bw
Dibenz(bf)-14-oxazepine (CR)					
Colored Smokes					
CI Basic Yellow 2					
Disperse Yellow 11					
Disperse Red 9					
Solvent Green 3					
Solvent Yellow 33					
Yellow Smoke 6					
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)					
1,3-Dinitrobenzene (1,3-DNB)					
2,4 – Dinitrophenol (2,4-DNP)					
Dinitrotoluene isomers					
2,4-Dinitrotoluene					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					
Nitrobenzene (NB)					
Nitroglycerin (NG)					
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)					
Pentaerythritol Tetranitrate (PETN)					
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)					
Trinitrophenylmethylnitramine (Tetryl)					
2,4,6-Trinitrotoluene (TNT)					
2 Concentration in aquatic insects estimated via equilibrium partitioning with sediment.					

Table 28 Continued.

Compound	Concentration in Terrestrial Insects[3] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves
Smokes and Obscurants							
Fog Oil Smoke	7.07E+02	1.04E+00	2.28E+02	**3.2E+00**	**2.5E+00**	**3.2E+00**	**2.5E+00**
Hexachloroethane (HC) Smoke	2.33E-03	2.29E-06	7.51E-04				
White Phosphorous (WP) Smoke	2.58E-02	2.53E-05	8.32E-03				
Brass Flakes							
Graphite Flakes							
Titanium Dioxide							
Polyethylene Glycol (PEG)							
Terephthalic Acid	2.69E-04	2.64E-07	8.66E-05				
(o-Chlorbenzol)malononitrile (CS)	4.50E-08	4.41E-11	1.45E-08				
Dibenz(bf)-14-oxazepine (CR)							
Colored Smokes							
CI Basic Yellow 2	1.05E-06	1.03E-09	3.39E-07				
Disperse Yellow 11	3.61E-04	3.54E-07	1.16E-04				
Disperse Red 9	2.07E-04	2.03E-07	6.68E-05				
Solvent Green 3	1.77E-08	1.73E-11	5.70E-09				
Solvent Yellow 33	6.69E-05	6.56E-08	2.15E-05				
Yellow Smoke 6	1.26E-06	1.24E-09	4.06E-07				
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.74E-01	1.70E-04	5.59E-02				
1,3-Dinitrobenzene (1,3-DNB)	1.03E-02	1.01E-05	3.32E-03				
2,4 - Dinitrophenol (2,4-DNP)							
Dinitrotoluene isomers	8.24E-03	8.08E-06	2.65E-03				
2,4-Dinitrotoluene	4.23E-07	4.14E-10	1.36E-07				

Compound	Concentration in Terrestrial Insects[3] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	3.75E-01	3.68E-04	1.21E-01				
Nitrobenzene (NB)							
Nitroglycerin (NG)	1.53E-01	1.50E-04	4.92E-02				
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)							
Pentaerythritol Tetranitrate (PETN)	4.46E-02	4.38E-05	1.44E-02				
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	1.61E+00	1.58E-03	5.18E-01		2.6E-03		2.6E-03
Trinitrophenylmethylnitramine (Tetryl)	9.38E-04	9.20E-07	3.02E-04		6.2E-06		6.2E-06
2,4,6-Trinitrotoluene (TNT)	8.90E-01	8.73E-04	2.87E-01		4.9E-03		4.9E-03
Bold values indicate exceedance of regulatory threshold.							

Table 28 Continued.

Compound	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker	NOAEL-based TQ for Tortoise	LOAEL-based TQ for Tortoise
Smokes and Obscurants				
Fog Oil Smoke			8.7E-01	2.1E-01
Hexachloroethane (HC) Smoke	5.2E-05	5.7E-06	1.4E-07	7.1E-08
White Phosphorous (WP) Smoke	**1.7E+00**	1.7E-01	1.7E-02	1.4E-02
Brass Flakes				
Graphite Flakes				
Titanium Dioxide				
Polyethylene Glycol (PEG)			7.4E-06	
Terephthalic Acid				
(o-Chlorbenzol)malononitrile (CS)				
Dibenz(bf)-14-oxazepine (CR)				

Compound	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker	NOAEL-based TQ for Tortoise	LOAEL-based TQ for Tortoise
Colored Smokes				
CI Basic Yellow 2				
Disperse Yellow 11				
Disperse Red 9				
Solvent Green 3				
Solvent Yellow 33			4.8E-07	4.8E-08
Yellow Smoke 6				
Military Unique Compounds				
1,3,5-Trinitrobenzene (1,3,5-TNB)			6.4E-04	1.3E-04
1,3-Dinitrobenzene (1,3-DNB)			8.9E-04	3.8E-04
2,4 - Dinitrophenol (2,4-DNP)				
Dinitrotoluene isomers			1.2E-04	1.2E-05
2,4-Dinitrotoluene			6.9E-08	6.9E-09
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)			1.2E-03	4.9E-04
Nitrobenzene (NB)				
Nitroglycerin (NG)			5.0E-04	4.7E-05
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)				
Pentaerythritol Tetranitrate (PETN)			2.6E-06	2.6E-07
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	2.3E-01	2.0E-01	2.3E-03	4.5E-04
Trinitrophenylmethylnitramine (Tetryl)			6.6E-06	1.3E-06
2,4,6-Trinitrotoluene (TNT)	4.1E-01	1.6E-02	5.5E-03	5.5E-04

Bold values indicate exceedance of regulatory threshold.

Table 29. Exposure and risk estimates for Fort Gordon, Georgia.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw
Smokes and Obscurants						
Fog Oil Smoke					NI	
Hexachloroethane (HC) Smoke	3.74	2584.64	3.96E-04	2.07E-05		
White Phosphorous (WP) Smoke	3.08					
Brass Flakes	-0.52				NI	
Graphite Flakes					NI	
Titanium Dioxide	2.23					
Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2	568.72	8.72E-05	4.65E-05		
(o-Chlorbenzol)malononitrile (CS)	2.76	412.92	6.33E-05	1.22E-05		
Dibenz(bf)-14-oxazepine (CR)	3.49					
Colored Smokes						
CI Basic Yellow 2	3.54					
Disperse Yellow 11	4.54	272.97	4.19E-05	7.50E-07		
Disperse Red 9	4.045	3566.77	5.47E-04	1.90E-05		
Solvent Green 3	8.995	12021.25	1.84E-03	8.61E-08		
Solvent Yellow 33	4.1	24261.57	3.72E-03	1.20E-04		
Yellow Smoke 6	6.28					
Dye Yellow 4 (Benzanthrone)	4.81					
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	406.36	6.23E-05	1.10E-04		
1,3-Dinitrobenzene (1,3-DNB)	1.49	406.36	6.23E-05	6.56E-05		
2,4 - Dinitrophenol (2,4-DNP)	1.67					

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw
Dinitrotoluene isomers	2.14					
2,4-Dinitrotoluene	1.98					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16					
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	270.64	4.15E-05	3.67E-05		
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61	1.84	2.83E-07	2.54E-07		
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87					
Trinitrophenylmethylnitramine (Tetryl)	2.4	370.50	5.68E-05	1.77E-05		
2,4,6-Trinitrotoluene (TNT)	1.6	40.64	6.23E-06	5.66E-06		
1 - NI indicates installation reports using fog oil or additives, but the amount used is not available						

Table 29 Continued.

Compound	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day
Smokes and Obscurants				
Fog Oil Smoke				
Hexachloroethane (HC) Smoke		1.26E-04	1.23E-07	4.06E-05
White Phosphorous (WP) Smoke				
Brass Flakes				
Graphite Flakes				
Titanium Dioxide				
Polyethylene Glycol (PEG)				
Terephthalic Acid		2.83E-04	2.77E-07	9.12E-05

Compound	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	Dose to Wood-pecker mg/kg-day
(o-Chlorbenzol)malononitrile (CS)		7.45E-05	7.30E-08	2.40E-05
Dibenz(bf)-14-oxazepine (CR)				
Colored Smokes				
CI Basic Yellow 2				
Disperse Yellow 11		4.57E-06	4.48E-09	1.47E-06
Disperse Red 9		1.16E-04	1.13E-07	3.72E-05
Solvent Green 3		5.24E-07	5.14E-10	1.69E-07
Solvent Yellow 33		7.31E-04	7.16E-07	2.35E-04
Yellow Smoke 6				
Dye Yellow 4 (Benzanthrone)				
Military Unique Compounds				
1,3,5-Trinitrobenzene (1,3,5-TNB)		6.73E-04	6.59E-07	2.17E-04
1,3-Dinitrobenzene (1,3-DNB)		4.00E-04	3.92E-07	1.29E-04
2,4 - Dinitrophenol (2,4-DNP)				
Dinitrotoluene isomers				
2,4-Dinitrotoluene				
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)				
Nitrobenzene (NB)				
Nitroglycerin (NG)		2.24E-04	2.19E-07	7.21E-05
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)				
Pentaerythritol Tetranitrate (PETN)		1.55E-06	1.52E-09	4.98E-07
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)				
Trinitrophenylmethylnitramine (Tetryl)		1.08E-04	1.06E-07	3.48E-05
2,4,6-Trinitrotoluene (TNT)		3.45E-05	3.38E-08	1.11E-05

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available

Table 29 Continued.

Compound	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
Smokes and Obscurants					
Fog Oil Smoke					
Hexachloroethane (HC) Smoke					
White Phosphorous (WP) Smoke					
Brass Flakes					
Graphite Flakes					
Titanium Dioxide					
Polyethylene Glycol (PEG)					
Terephthalic Acid					
(o-Chlorbenzol)malononitrile (CS)					
Dibenz(bf)-14-oxazepine (CR)					
Colored Smokes					
CI Basic Yellow 2					
Disperse Yellow 11					
Disperse Red 9					
Solvent Green 3					
Solvent Yellow 33				5.27E-06	5.27E-07
Yellow Smoke 6					
Dye Yellow 4 (Benzanthrone)					
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)					
1,3-Dinitrobenzene (1,3-DNB)					
2,4 - Dinitrophenol (2,4-DNP)					
Dinitrotoluene isomers					

Compound	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
2,4-Dinitrotoluene					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					
Nitrobenzene (NB)					
Nitroglycerin (NG)					
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)					
Pentaerythritol Tetranitrate (PETN)				8.91E-11	8.91E-12
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)					
Trinitrophenylmethylnitramine (Tetryl)	7.10E-07				
2,4,6-Trinitrotoluene (TNT)	1.89E-07	1.59E-05	6.24E-07	2.11E-07	2.11E-08
1 - NI indicates installation reports using fog oil or additives, but the amount used is not available					

Table 30. Exposure and risk estimates for Fort Stewart, Georgia.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concen-tration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Up-take mg/kg ww	Mass of smokes Fog Oil and addi-tives into air[2] gallons	Concentration in Terrestrial Insects[3] g/kg bw
Smokes and Obscurants						
Fog Oil Smoke					NI	
Hexachloroethane (HC) Smoke	3.74	42416.50	3.99E-03	2.08E-04		1.27E-03
White Phosphorous (WP) Smoke	3.08	2304193.95	2.17E-01	2.73E-02		1.66E-01
Brass Flakes	-0.52				NI	
Graphite Flakes					NI	
Titanium Dioxide	2.23					

Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2	5687.23	5.35E-04	2.85E-04		1.73E-03
(o-Chlorbenzol)malononitrile (CS)	2.76	147963.56	1.39E-02	2.69E-03		1.64E-02
Dibenz(bf)-14-oxazepine (CR)	3.49					
Colored Smokes						
CI Basic Yellow 2	3.54					
Disperse Yellow 11	4.54	6336.57	5.96E-04	1.07E-05		6.50E-05
Disperse Red 9	4.045					
Solvent Green 3	8.995					
Solvent Yellow 33	4.1	1631.30	1.53E-04	4.95E-06		3.01E-05
Yellow Smoke 6	6.28					
Dye Yellow 4 (Benzanthrone)	4.81					
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	476640.82	4.48E-02	7.94E-02		4.84E-01
1,3-Dinitrobenzene (1,3-DNB)	1.49	476640.82	4.48E-02	4.72E-02		2.87E-01
2,4 - Dinitrophenol (2,4-DNP)	1.67			0. +00		
Dinitrotoluene isomers	2.14	300492.42	2.82E-02	1.25E-02		7.60E-02
2,4-Dinitrotoluene	1.98					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	82573.82	7.76E-03	4.83E-02		2.94E-01
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	510340.63	4.80E-02	4.25E-02		2.59E-01
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61	12680.30	1.19E-03	1.07E-03		6.51E-03
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	1339375.31	1.26E-01	3.03E-01		1.85E+00
Trinitrophenylmethylnitramine (Tetryl)	2.4	19.50	1.83E-06	5.72E-07		3.48E-06
2,4,6-Trinitrotoluene (TNT)	1.6	4766408.21	4.48E-01	4.07E-01		2.48E+00

1. NI indicates installation reports using fog oil or additives, but the amount used is not available.
2. Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 30 Continued.

Compound	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
Smokes and Obscurants							
Fog Oil Smoke							
Hexachloroethane (HC) Smoke	1.24E-06	4.08E-04		2.8E-05	1.3E-05	7.8E-08	3.9E-08
White Phosphorous (WP) Smoke	1.63E-04	5.35E-02		**1.1E+01**	**1.1E+00**	1.1E-01	9.3E-02
Brass Flakes							
Graphite Flakes							
Titanium Dioxide							
Polyethylene Glycol (PEG)							
Terephthalic Acid	1.70E-06	5.59E-04					
(o-Chlorbenzol)malononitrile (CS)	1.60E-05	5.27E-03					
Dibenz(bf)-14-oxazepine (CR)							
Colored Smokes							
CI Basic Yellow 2							
Disperse Yellow 11	6.37E-08	2.09E-05					
Disperse Red 9							
Solvent Green 3							
Solvent Yellow 33	2.95E-08	9.70E-06				2.2E-07	2.2E-08
Yellow Smoke 6							
Dye Yellow 4 (Benzanthrone)							
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)	4.74E-04	1.56E-01				1.8E-03	3.5E-04
1,3-Dinitrobenzene (1,3-DNB)	2.82E-04	9.25E-02				2.5E-02	1.1E-02
2,4 - Dinitrophenol (2,4-DNP)							
Dinitrotoluene isomers	7.45E-05	2.45E-02				1.1E-03	1.1E-04

Compound	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
2,4-Dinitrotoluene							
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2.88E-04	9.47E-02				9.6E-04	3.8E-04
Nitrobenzene (NB)							
Nitroglycerin (NG)	2.53E-04	8.33E-02				8.4E-04	7.9E-05
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)							
Pentaerythritol Tetranitrate (PETN)	6.38E-06	2.10E-03				3.8E-07	3.8E-08
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	1.81E-03	5.95E-01	3.0E-03	2.7E+00	2.3E+00	2.6E-03	5.2E-04
Trinitrophenylmethylnitramine (Tetryl)	3.42E-09	1.12E-06	2.3E-08			2.4E-08	5.0E-09
2,4,6-Trinitrotoluene (TNT)	2.43E-03	7.99E-01	1.4E-02	**1.1E+00**	4.5E-02	1.5E-02	1.5E-03
Bold values indicate excedance of regulatory threshold.							

Table 31. Exposure and risk estimates for Fort Campbell, Kentucky.

Compound	log Kow	Sum of COC Weight (g) Ad-justed for Dud Rate	Soil Concen-tration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Up-take mg/kg ww	Mass of smokes Fog Oil and addi-tives into air[1] gallons	Concentration in Terrestrial Insects[2] mg/kg bw
Smokes and Obscurants						
Fog Oil Smoke					NI	
Hexachloroethane (HC) Smoke	3.74	244893.70	1.83E-02	9.54E-04		5.81E-03
White Phosphorous (WP) Smoke	3.08	861538.01	6.44E-02	8.11E-03		4.94E-02
Brass Flakes	-0.52				NI	

Graphite Flakes					NI	
Titanium Dioxide	2.23					
Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2	177.73	1.33E-05	7.07E-06		4.31E-05
(o-Chlorbenzol)malononitrile (CS)	2.76	770090.41	5.75E-02	1.11E-02		6.77E-02
Dibenz(bf)-14-oxazepine (CR)	3.49					
Colored Smokes						
CI Basic Yellow 2	3.54					
Disperse Yellow 11	4.54	14112.71	1.05E-03	1.89E-05		1.15E-04
Disperse Red 9	4.045	232.76	1.74E-05	6.04E-07		3.68E-06
Solvent Green 3	8.995	3311.19	2.47E-04	1.16E-08		7.04E-08
Solvent Yellow 33	4.1	2460.32	1.84E-04	5.93E-06		3.61E-05
Yellow Smoke 6	6.28	378.00	2.82E-05	4.95E-08		3.02E-07
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	4153253.86	3.10E-01	5.50E-01		3.35E+00
1,3-Dinitrobenzene (1,3-DNB)	1.49	4153253.86	3.10E-01	3.27E-01		1.99E+00
2,4 – Dinitrophenol (2,4-DNP)	1.67					
Dinitrotoluene isomers	2.14	1576894.44	1.18E-01	5.21E-02		3.17E-01
2,4-Dinitrotoluene	1.98					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	660770.57	4.94E-02	3.07E-01		1.87E+00
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	21285652.91	1.59E+00	1.41E+00		8.57E+00
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61	826950.29	6.18E-02	5.54E-02		3.37E-01
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	38016812.33	2.84E+00	6.84E+00		4.17E+01
Trinitrophenylmethylnitramine (Tetryl)	2.4	111280.91	8.32E-03	2.60E-03		1.58E-02
2,4,6-Trinitrotoluene (TNT)	1.6	41532538.61	3.10E+00	2.82E+00		1.72E+01

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available.

2 - concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves

Table 31 Continued.

Compound	Dose to Indiana Bat mg/kg-day	Dose to Gray Bat mg/kg-day	NOAEL-based TQ for Indiana Bat	LOAEL-based TQ for Indiana Bat	NOAEL-based TQ for Gray Bat	LOAEL-based TQ for Gray Bat
Smokes and Obscurants						
Fog Oil Smoke						
Hexachloroethane (HC) Smoke	3.09E-03	2.35E-03	1.9E-05	9.6E-06	1.5E-05	7.4E-06
White Phosphorous (WP) Smoke	2.62E-02	2.00E-02	**1.7E+00**	**1.5E+00**	**1.3E+00**	**1.1E+00**
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						
Polyethylene Glycol (PEG)						
Terephthalic Acid	2.29E-05	1.74E-05	6.4E-06		4.9E-06	
(o-Chlorbenzol)malononitrile (CS)	3.59E-02	2.74E-02				
Dibenz(bf)-14-oxazepine (CR)						
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11	6.11E-05	4.66E-05				
Disperse Red 9	1.95E-06	1.49E-06				
Solvent Green 3	3.74E-08	2.85E-08				
Solvent Yellow 33	1.92E-05	1.46E-05	1.4E-05	1.4E-06	1.1E05	1.1E-06
Yellow Smoke 6	1.60E-07	1.22E-07				
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.78E+00	1.36E+00	6.7E-01	1.3E-01	5.1E-01	1.0E-01
1,3-Dinitrobenzene (1,3-DNB)	1.06E+00	8.05E-01	**9.4E+00**	**4.0E+00**	**7.1E+00**	**3.1E+00**
2,4 - Dinitrophenol (2,4-DNP)						
Dinitrotoluene isomers	1.68E-02	1.2E-01	2.4E-01	2.4E-02	1.8E-01	1.8E-02
2,4-Dinitrotoluene						

Compound	Dose to Indiana Bat mg/kg-day	Dose to Gray Bat mg/kg-day	NOAEL-based TQ for Indiana Bat	LOAEL-based TQ for Indiana Bat	NOAEL-based TQ for Gray Bat	LOAEL-based TQ for Gray Bat
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	9.93E-01	7.57E-01	3.3E-01	1.3E-01	2.5E-01	1.0E-01
Nitrobenzene (NB)						
Nitroglycerin (NG)	4.55E+00	3.47E+00	**1.5E+00**	1.4E-01	**1.2E+00**	1.1E-01
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)						
Pentaerythritol Tetranitrate (PETN)	1.79E-01	1.37E-01	1.1E-03	1.1E-04	8.0E-04	8.0E-05
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	2.21E+01	1.69E+01	**3.2E+00**	6.3E-01	**2.4E+00**	4.8E-01
Trinitrophenylmethylnitramine (Tetryl)	8.40E-03	6.40E-03	6.0E-03	1.2E-03	4.6E-03	9.3E-04
2,4,6-Trinitrotoluene (TNT)	9.13E+00	6.95E+00	**5.7E+00**	5.7E-01	**4.3E+00**	4.3E-01
Bold values indicate excedance of regulatory threshold.						

Table 32. Exposure and risk estimates for Fort Knox, Kentucky.

Compound	log Kow	Sum Of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
Smokes and Obscurants							
Fog Oil Smoke					5.50E+01	7.23E+00	1.92E+01
Hexachloroethane (HC) Smoke	3.74						
White Phosphorous (WP) Smoke	3.08	21092.40	3.89E-04	4.90E-05			
Brass Flakes	-0.52				NI		

Compound	log Kow	Sum Of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
Graphite Flakes					NI		
Titanium Dioxide	2.23						
Polyethylene Glycol (PEG)	-1.2						
Terephthalic Acid	2	29680.24	5.47E-04	2.92E-04			
(o-Chlorbenzol)malononitrile (CS)	2.76	2971.55	5.48E-05	1.06E-05			
Dibenz(bf)-14-oxazepine (CR)	3.49						
Colored Smokes							
CI Basic Yellow 2	3.54						
Disperse Yellow 11	4.54	4059.25	7.49E-05	1.34E-06			
Disperse Red 9	4.045	6264.09	1.16E-04	4.01E-06			
Solvent Green 3	8.995	23080.80	4.26E-04	1.99E-08			
Solvent Yellow 33	4.1	37376.23	6.89E-04	2.22E-05			
Yellow Smoke 6	6.28						
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	161664.43	2.98E-03	5.28E-03			
1,3-Dinitrobenzene (1,3-DNB)	1.49	161664.43	2.98E-03	3.14E-03			
2,4 - Dinitrophenol (2,4-DNP)	1.67						
Dinitrotoluene isomers	2.14	1958963.96	3.61E-02	1.60E-02			
2,4-Dinitrotoluene	1.98						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	123968.16	2.29E-03	1.42E-02			
Nitrobenzene (NB)	1.85						
Nitroglycerin (NG)	1.62	1102247.48	2.03E-02	1.80E-02			

Compound	log Kow	Sum Of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9						
Pentaerythritol Tetranitrate (PETN)	1.61	64939.29	1.20E-03	1.07E-03			
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	2973173.61	5.48E-02	1.32E-01			
Trinitrophenylmethylnitramine (Tetryl)	2.4	11943.66	2.20E-04	6.88E-05			
2,4,6-Trinitrotoluene (TNT)	1.6	1616644.33	2.98E-02	2.71E-02			

NI = no information available.

Table 32 Continued.

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves µg/cm2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Indiana Bat mg/kg-day	Dose to Gray Bat mg/kg-day
Smokes and Obscurants						
Fog Oil Smoke	1.28E+01	1.92E+01	1.47E+01	7.78E+01	3.46E+01	1.10E+01
Hexachloroethane (HC) Smoke						
White Phosphorous (WP) Smoke		7.35E-05		2.98E-04	1.27E-04	2.41E-05
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						
Polyethylene Glycol (PEG)						
Terephthalic Acid		4.37E-04		1.78E-03	7.55E-04	1.44E-04
(o-Chlorbenzol)malononitrile (CS)		1.59E-05		6.44E-05	2.74E-05	5.22E-06
Dibenz(bf)-14-oxazepine (CR)						
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11		2.01E-06		8.17E-06	3.47E-06	6.61E-07
Disperse Red 9		6.01E-06		2.44E-05	1.04E-05	1.98E-06
Solvent Green 3		2.98E-08		1.21E-07	5.15E-08	9.80E-09
Solvent Yellow 33		3.33E-05		1.35E-04	5.75E-05	1.10E-05
Yellow Smoke 6						
Dye Yellow 4 (Benzanthrone)						
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)				3.22E-02	1.71E-02	1.30E-02
1,3-Dinitrobenzene (1,3-DNB)				1.9.E-02	1.02E-02	7.74E-03

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves µg/cm2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Indiana Bat mg/kg-day	Dose to Gray Bat mg/kg-day
2,4 - Dinitrophenol (2,4-DNP)						
Dinitrotoluene isomers				9.72E-02	5.17E-02	3.94E-02
2,4-Dinitrotoluene						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)				8.66E-02	4.60E-02	3.50E-02
Nitrobenzene (NB)						
Nitroglycerin (NG)				1.10E-01	5.82E-02	4.43E-02
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)						
Pentaerythritol Tetranitrate (PETN)				6.54E-03	3.48E-03	2.65E-03
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)				8.05E-01	4.27E-01	3.26E-01
Trinitrophenylmethylnitramine (Tetryl)				4.19E-04	2.23E-04	1.70E-04
2,4,6-Trinitrotoluene (TNT)				1.65E-01	8.77E-02	6.68E-02

1 - Concentration in aquatic insects estimated via equilibrium partitioning with sediment.

2 - Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 32 Continued.

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Indiana Bat	LOAEL-based TQ for Indiana Bat	NOAEL-based TQ for Gray Bat	LOAEL-based TQ for Gray Bat
Smokes and Obscurants								
Fog Oil Smoke	3.5E-01	2.8E-01	3.5E-01	2.8E-01	**2.9E+00**	6.9E-01	9.2E-01	2.2E-01
Hexachloroethane (HC) Smoke								
White Phosphorous (WP) Smoke					8.5E-03	7.2E-03	1.6E-03	1.4E-03
Brass Flakes								
Graphite Flakes								
Titanium Dioxide								
Polyethylene Glycol (PEG)								
Terephthalic Acid					2.1E-04		4.0E-05	
(o-Chlorbenzol)malononitrile (CS)								
Dibenz(bf)-14-oxazepine (CR)								
Colored Smokes								
CI Basic Yellow 2								
Disperse Yellow 11								
Disperse Red 9								
Solvent Green 3								
Solvent Yellow 33					4.2E-05	4.2E-06	8.1E-06	8.1E-07
Yellow Smoke 6								
Dye Yellow 4 (Benzanthrone)								
Military Unique Compounds								
1,3,5-Trinitrobenzene (1,3,5-TNB)					6.5E-02	1.3E-02	4.9E-02	9.7E-03
1,3-Dinitrobenzene (1,3-DNB)					9.1E-01	3.8E-01	6.8E-01	2.9E-01
2,4 - Dinitrophenol (2,4-DNP)								

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Indi-ana Bat	LOAEL-based TQ for Indi-ana Bat	NOAEL-based TQ for Gray Bat	LOAEL-based TQ for Gray Bat
Dinitrotoluene isomers					7.4E-02	7.4E-02	5.6E-02	5.6E-03
2,4-Dinitrotoluene								
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					1.5E-02	6.1E-03	1.2E-02	4. 7E-03
Nitrobenzene (NB)								
Nitroglycerin (NG)					1.9E-02	1.8E-03	1.5E-02	1.4E-03
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)								
Pentaerythritol Tetranitrate (PETN)					2.0E-05	2.0E-06	1.6E-05	1.6E-06
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	1.3E-03			1.3E-03	6.1E-04	1.2E-02	4.7E-02	9.3E-03
Trinitrophenylmethylnitramine (Tetryl)	2.8E-06			2.8E-06	1.6E-04	3.2E-05	1.2E-042	2.5E-05
2,4,6-Trinitrotoluene (TNT)	9.0E-04			9.0E-04	5.5E-02	5.5E-02	4.2E-02	4.2E-03

Bold values indicate exceedance of regulatory threshold.

Table 33. Exposure and risk estimates for Fort Polk, Louisiana.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons	Concentration in Terrestrial Insects[2] mg/kg bw
Smokes and Obscurants						
Fog Oil Smoke					NI	
Hexachloroethane (HC) Smoke	3.74	138185.58	3.10E-02	1.62E-03		9.84E-03
White Phosphorous (WP) Smoke	3.08	2212022.67	4.96E-01	6.24E-02		3.80E-01
Brass Flakes	-0.52				NA	
Graphite Flakes					NA	
Titanium Dioxide	2.23					
Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2	129029.07	2.89E-02	1.54E-02		9.38E-02
(o-Chlorbenzol)malononitrile (CS)	2.76	231802.88	5.20E-02	1.00E-02		6.11E-02
Dibenz(bf)-14-oxazepine (CR)	3.49	489.88	1.10E-04	8.00E-06		4.87E-05
Colored Smokes						
CI Basic Yellow 2	3.54	1350.74	3.03E-04	2.06E-05		1.26E-04
Disperse Yellow 11	4.54	3934.38	8.82E-04	1.58E-05		9.62E-05
Disperse Red 9	4.045	17966.75	4.03E-03	1.40E-04		8.51E-04
Solvent Green 3	8.995	52140.53	1.17E-02	5.46E-07		3.32E-06
Solvent Yellow 33	4.1	66705.79	1.50E-02	4.82E-04		2.94E-03
Yellow Smoke 6	6.28	858.06	1.92E-04	3.37E-07		2.05E-06
Dye Yellow 4 (Benzanthrone)	4.81	7251.69				
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	484999.93	1.09E-01	1.93E-01		1.17E+00
1,3-Dinitrobenzene (1,3-DNB)	1.49	48499.99	1.09E-02	1.14E-02		6.97E-02
2,4 – Dinitrophenol (2,4-DNP)	1.67					

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons	Concentration in Terrestrial Insects[2] mg/kg bw
Dinitrotoluene isomers	2.14	72466.06	1.62E-02	7.18E-03		4.37E-02
2,4-Dinitrotoluene	1.98					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	52617.75	1.18E-02	7.33E-02		4.47E-01
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	279307.25	6.26E-02	5.54E-02		3.37E-01
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61	3472966.54	7.79E-01	6.98E-01		4.25E+00
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	1039753.88	2.33E-01	5.62E-01		3.42E+00
Trinitrophenylmethylnitramine (Tetryl)	2.4	634.04	1.42E-04	4.44E-05		2.70E-04
2,4,6-Trinitrotoluene (TNT)	1.6	4849999.29	1.09E+00	9.88E-01		6.02E+00

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available. NA indicates not applicable (not used).

2 - Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 33 Continued.

Compound	Dose to Woodpecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker
Smokes and Obscurants				
Fog Oil Smoke				
Hexachloroethane (HC) Smoke	3.17E-03			
White Phosphorous (WP) Smoke	1.22E-01		**2.45E+01**	**2.45E+00**

Compound	Dose to Wood-pecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker
Brass Flakes				
Graphite Flakes				
Titanium Dioxide				
Polyethylene Glycol (PEG)				
Terephthalic Acid	3.02E-02			
(o-Chlorbenzol)malononitrile (CS)	1.97E-02			
Dibenz(bf)-14-oxazepine (CR)	1.57E-05			
Colored Smokes				
CI Basic Yellow 2	4.05E-05			
Disperse Yellow 11	3.10E-05			
Disperse Red 9	2.74E-04			
Solvent Green 3	1.07E-06			
Solvent Yellow 33	9.46E-04			
Yellow Smoke 6	6.62E-07			
Dye Yellow 4 (Benzanthrone)				
Military Unique Compounds				
1,3,5-Trinitrobenzene (1,3,5-TNB)				
1,3-Dinitrobenzene (1,3-DNB)	2.24E-02			
2,4 - Dinitrophenol (2,4-DNP)				
Dinitrotoluene isomers	1.41E-02			
2,4-Dinitrotoluene				
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	1.44E-01			
Nitrobenzene (NB)				
Nitroglycerin (NG)	1.09E-01			
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)				
Pentaerythritol Tetranitrate (PETN)	1.37E+00			

Compound	Dose to Woodpecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	1.10E+00	5.62E-03	**4.9E+00**	**4.2E+00**
Trinitrophenylmethylnitramine (Tetryl)	8.71E-05	1.78E-06		
2,4,6-Trinitrotoluene (TNT)	1.94E+00	3.29E-02	**2.8E+00**	1.09E-01
Bold values indicate exceedance of regulatory threshold.				

Table 34. Exposure and risk estimates for Camp Shelby, Mississippi.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration on Plants from Direct Deposition mg/kg ww
Smokes and Obscurants						
Fog Oil Smoke					8.00E+02	2.79E+02
Hexachloroethane (HC) Smoke	3.74					
White Phosphorous (WP) Smoke	3.08	2450549.85	5.95E-01	7.49E-02		
Brass Flakes	-0.52				NA	
Graphite Flakes					NA	
Titanium Dioxide	2.23					
Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2					
(o-Chlorbenzol)malononitrile (CS)	2.76					
Dibenz(bf)-14-oxazepine (CR)	3.49					

Colored Smokes						
CI Basic Yellow 2	3.54					
Disperse Yellow 11	4.54	1101.43	2.67E-04	4.79E-06		
Disperse Red 9	4.045	1314.43	3.19E-04	1.11E-05		
Solvent Green 3	8.995	3077.44	7.47E-04	3.49E-08		
Solvent Yellow 33	4.1	1304.00	3.17E-04	1.02E-05		
Yellow Smoke 6	6.28					
Dye Yellow 4 (Benzanthrone)	4.81					
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1					
1,3-Dinitrobenzene (1,3-DNB)	1.49	42510.69	1.03E-02	1.09E-02		
2,4 – Dinitrophenol (2,4-DNP)	1.67					
Dinitrotoluene isomers	2.14	19838.64	4.82E-03	2.13E-03		
2,4-Dinitrotoluene	1.98					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	24503.76	5.95E-03	3.70E-02		
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	34125.74	8.29E-03	7.33E-03		
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61	10798.13	2.62E-03	2.35E-03		
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	298265.05	7.24E-02	1.75E-01		
Trinitrophenylmethylnitramine (Tetryl)	2.4					
2,4,6-Trinitrotoluene (TNT)	1.6	4251069.12	1.03E+00	9.38E-01		
NA = not applicable (not used).						

Table 34 Continued.

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves µg/cm[2]	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day
Smokes and Obscurants						
Fog Oil Smoke	1.86E+02	2.79E+02	2.13E+02	1.13E+03	1.66E+00	3.64E+02
Hexachloroethane (HC) Smoke						
White Phosphorous (WP) Smoke		1.12E-01		4.56E-01	4.47E-04	1.47E-01
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						
Polyethylene Glycol (PEG)						
Terephthalic Acid						
(o-Chlorbenzol)malononitrile (CS)						
Dibenz(bf)-14-oxazepine (CR)						
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11		7.19E-06		2.92E-05	2.86E-08	9.40E-06
Disperse Red 9		1.66E-05		6.75E-05	6.61E-08	2.17E-05
Solvent Green 3		5.24E-08		2.13E-07	2.08E-10	6.85E-08
Solvent Yellow 33		1.53E-05		6.22E-05	6.10E-08	2.00E-05
Yellow Smoke 6						
Dye Yellow 4 (Benzanthrone)						
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)		2.74E-01		1.11E+00	1.09E-03	3.59E-01
1,3-Dinitrobenzene (1,3-DNB)		1.63E-02		6.62E-02	6.49E-05	2.13E-02
2,4 – Dinitrophenol (2,4-DNP)						

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves µg/cm²	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Gopher Tortoise mg/kg-day	Dose to Woodpecker mg/kg-day
Dinitrotoluene isomers		3.19E-03		1.30E-02	1.27E-05	4.18E-03
2,4-Dinitrotoluene						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)		5.55E-02		2.25E-01	2.21E-04	7.26E-02
Nitrobenzene (NB)						
Nitroglycerin (NG)		1.10E-02		4.47E-02	4.38E-05	1.44E-02
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)						
Pentaerythritol Tetranitrate (PETN)		3.53E-03		1.43E-02	1.40E-05	4.61E-03
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		2.62E-01		1.06E+00	1.04E-03	3.42E-01
Trinitrophenylmethylnitramine (Tetryl)						
2,4,6-Trinitrotoluene (TNT)		1.41E+00		5.71E+00	5.60E-03	1.84E+00
1 Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.						

Table 34 Continued.

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
Smokes and Obscurants								
Fog Oil Smoke	**5.1E+00**	**4.0E+00**	**5.1E+00**	**4.0E+00**			**1.4E+00**	**3.3E-01**
Hexachloroethane (HC) Smoke								

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
White Phosphorous (WP) Smoke					**2.9E+01**	**2.9E+00**	3.0E-01	2.6E-01
Brass Flakes								
Graphite Flakes								
Titanium Dioxide								
Polyethylene Glycol (PEG)								
Terephthalic Acid								
(o-Chlorbenzol)malononitrile (CS)								
Dibenz(bf)-14-oxazepine (CR)								
Colored Smokes								
CI Basic Yellow 2								
Disperse Yellow 11								
Disperse Red 9								
Solvent Green 3								
Solvent Yellow 33							4.5E-07	4.5E-08
Yellow Smoke 6								
Dye Yellow 4 (Benzanthrone)								
Military Unique Compounds								
1,3,5-Trinitrobenzene (1,3,5-TNB)							4.1E-03	8.2E-04
1,3-Dinitrobenzene (1,3-DNB)							5.7E-03	2.5E-03
2,4 - Dinitrophenol (2,4-DNP)								
Dinitrotoluene isomers							1.8E-04	1.8E-05
2,4-Dinitrotoluene								
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)							7.4E-04	2.9E-04
Nitrobenzene (NB)								

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker	NOAEL-based TQ for Tor-toise	LOAEL-based TQ for Tor-toise
Nitroglycerin (NG)							1.5E-04	1.4E-05
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)								
Pentaerythritol Tetranitrate (PETN)							8.3E-07	8.3E-08
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)				1.7E-03	1.5E-01	1.30E+00	1.5E-03	3.0E-04
Trinitrophenylmethylnitramine (Tetryl)								
2,4,6-Trinitrotoluene (TNT)				3.1E-02	**2.6E+00**	1.0E-01	3.5E-02	3.5E-03

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available.

Bold values indicate exceedance of regulatory threshold.

Table 35. Exposure and risk estimates for Fort Leonard Wood, Missouri.

Compound	log Kow	Sum of COC Weight (g) Ad-justed for Dud Rate	Soil Concen-tration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Up-take mg/kg ww	Mass of smokes Fog Oil and additives into air gal-lons	Concentration in sediment - deposi-tion (top 1 cm dry) mg/kg dw
Smokes and Obscurants						
Fog Oil Smoke					3.65E+04	4.80E+03
Hexachloroethane (HC) Smoke	3.74	6412.32	2.37E-02	1.23E-03		
White Phosphorous (WP) Smoke	3.08					
Brass Flakes	-0.52				NA	
Graphite Flakes					NA	
Titanium Dioxide	2.23	209016.00	7.71E-01	3.02E-01		

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw
Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2	303378.28	1.12E+00	5.96E-01		
(o-Chlorbenzol)malononitrile (CS)	2.76	206764.18	7.63E-01	1.47E-01		
Dibenz(bf)-14-oxazepine (CR)	3.49					
Colored Smokes						
CI Basic Yellow 2	3.54					
Disperse Yellow 11	4.54	22452.13	8.28E-02	1.48E-03		
Disperse Red 9	4.045	218657.21	8.07E-01	2.80E-02		
Solvent Green 3	8.995	242660.58	8.95E-01	4.18E-05		
Solvent Yellow 33	4.1	480500.01	1.77E+00	5.72E-02		
Yellow Smoke 6	6.28					
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	184845.77	6.82E-01	1.21E+00		
1,3-Dinitrobenzene (1,3-DNB)	1.49	184845.77	6.82E-01	7.18E-01		
2,4 - Dinitrophenol (2,4-DNP)	1.67					
Dinitrotoluene isomers	2.14	7.43	2.74E-05	1.21E-05		
2,4-Dinitrotoluene	1.98					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	2.00	7.37E-06	4.58E-05		
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	32685.56	1.21E-01	1.07E-01		
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61	6022317.08	2.22E+01	1.99E+01		

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	3653834.18	1.35E+01	3.25E+01		
Trinitrophenylmethylnitramine (Tetryl)	2.4	1257.03	4.64E-03	1.45E-03		
2,4,6-Trinitrotoluene (TNT)	1.6	1848457.72	6.82E+00	6.20E+00		

Table 35 Continued.

Compound	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total concentration in Tree Leaves $\mu g/cm^2$	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Indiana Bat mg/kg-day	Dose to Gray Bat mg/kg-day
Smokes and Obscurants							
Fog Oil Smoke	1.27E+04	8.48E+03	1.27E+04	9.74E+03	5.16E+04	2.30E+04	4.97E+03
Hexachloroethane (HC) Smoke			1.85E-03		7.51E-03	3.99E-03	3.04E-03
White Phosphorous (WP) Smoke			0.00E+00				
Brass Flakes							
Graphite Flakes							
Titanium Dioxide			4.53E-01		1.84E+00	9.77E-01	7.45E-01
Polyethylene Glycol (PEG)							
Terephthalic Acid			8.94E-01		3.63E+00	1.93E+01	1.47E+00
(o-Chlorbenzol)malononitrile (CS)			2.21E-01		8.97E-01	4.76E-01	3.63E-01
Dibenz(bf)-14-oxazepine (CR)							
Colored Smokes							
CI Basic Yellow 2							
Disperse Yellow 11			2.23E-03		9.04E-03	4.80E-03	3.66E-03

Compound	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total concentration in Tree Leaves µg/cm²	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Indiana Bat mg/kg-day	Dose to Gray Bat mg/kg-day
Disperse Red 9			4.20E-02		1.70E-01	9.06E-02	6.90E-02
Solvent Green 3			6.27E-05		2.55E-04	1.35E-04	1.03E-04
Solvent Yellow 33			8.57E-02		3.48E-01	1.85E-01	1.41E-01
Yellow Smoke 6							
Dye Yellow 4 (Benzanthrone)							
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)					7.36E+00	3.91E+00	2.98E+00
1,3-Dinitrobenzene (1,3-DNB)					4.37E+00	2.32E+00	1.77E+00
2,4 - Dinitrophenol (2,4-DNP)							
Dinitrotoluene isomers					7.37E-05	3.92E-05	2.98E-05
2,4-Dinitrotoluene							
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					2.79E-04	1.48E-04	1.13E-04
Nitrobenzene (NB)							
Nitroglycerin (NG)					6.50E-01	3.45E-01	2.63E-01
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)							
Pentaerythritol Tetranitrate (PETN)					1.21E+02	6.45E+01	4.91E+01
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)					1.98E+02	1.05E+02	8.00E+01
Trinitrophenylmethylnitramine (Tetryl)					8.82E-03	4.68E-03	3.57E-03
2,4,6-Trinitrotoluene (TNT)					3.77E+01	2.00E+01	1.53E+01

1 - Concentration in aquatic insects estimated via equilibrium partitioning with sediment.

2 - Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 35 Continued.

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Indiana Bat	LOAEL-based TQ for Indiana Bat	NOAEL-based TQ for Gray Bat	LOAEL-based TQ for Gray Bat
Smokes and Obscurants								
Fog Oil Smoke	**2.5E+02**	**1.8E+02**	**2.3E+02**	**1.8E+02**	**1.9E+03**	**4.6E+02**	**4.1E+02**	**9.9E+01**
Hexachloroethane (HC) Smoke					2.5E-05	1.2E-05	1.9E-05	9.5E-06
White Phosphorous (WP) Smoke								
Brass Flakes								
Graphite Flakes								
Titanium Dioxide								
Polyethylene Glycol (PEG)								
Terephthalic Acid					5.4E-01		4.1E-01	
(o-Chlorbenzol)malononitrile (CS)								
Dibenz(bf)-14-oxazepine (CR)								
Colored Smokes								
CI Basic Yellow 2								
Disperse Yellow 11								
Disperse Red 9								
Solvent Green 3								
Solvent Yellow 33					1.4E-01	1.4E-02	1.0E-01	1.0E-02
Yellow Smoke 6								
Dye Yellow 4 (Benzanthrone)								
Military Unique Compounds								
1,3,5-Trinitrobenzene (1,3,5-TNB)					**1.5E+00**	2.9E-01	**1.1E+00**	2.2E-01
1,3-Dinitrobenzene (1,3-DNB)					**2.1E+01**	**8.80E-01**	**1.6E+01**	**6.70E+0**
2,4 - Dinitrophenol (2,4-DNP)								
Dinitrotoluene isomers					5.6E-05	5.6E-06	4.3E-05	4.3E-06

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Indiana Bat	LOAEL-based TQ for Indiana Bat	NOAEL-based TQ for Gray Bat	LOAEL-based TQ for Gray Bat
2,4-Dinitrotoluene								
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					4.9E-05	2.0E-05	3.8E-05	1.5E-05
Nitrobenzene (NB)								
Nitroglycerin (NG)					1.2E-01	1.1E-02	8.8E-02	8.2E-03
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)								
Pentaerythritol Tetranitrate (PETN)					3.8E-01	3.8E-02	2.9E-01	2.9E-02
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		3.2E-01		3.2E-01	**1.5E+01**	**3.0E+00**	**1.1E+01**	**2.3E+00**
Trinitrophenylmethylnitramine (Tetryl)		5.8E-05		5.8E-05	3.3E-03	6.8E-04	2.5E-03	5.2E-04
2,4,6-Trinitrotoluene (TNT)		2.1E-01		2.1E-01	**1.3E+01**	**1.3E+00**	**9.5E+00**	9.5E-01

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available.
Bold values indicate exceedance of regulatory threshold.

Table 36. Exposure and risk estimates for Fort Bragg, North Carolina.

Compound	log Kow	Sum of COC Weight (g) Adjusted for 10% Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons
Smokes and Obscurants					
Fog Oil Smoke					NI
Hexachloroethane (HC) Smoke	3.74	576047.73	3.29E-02	1.72E-03	
White Phosphorous (WP) Smoke	3.08	5982139.69	3.42E-01	4.30E-02	
Brass Flakes	-0.52				NA
Graphite Flakes					NI
Titanium Dioxide	2.23				

Compound	log Kow	Sum of COC Weight (g) Adjusted for 10% Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons
Polyethylene Glycol (PEG)	-1.2				
Terephthalic Acid	2	449646.77	2.57E-02	1.37E-02	
(o-Chlorbenzol)malononitrile (CS)	2.76	988.98	5.65E-05	1.09E-05	
Dibenz(bf)-14-oxazepine (CR)	3.49				
Colored Smokes					
CI Basic Yellow 2	3.54	479.30	2.74E-05	1.87E-06	
Disperse Yellow 11	4.54	15255.54	8.72E-04	1.56E-05	
Disperse Red 9	4.045	57636.47	3.29E-03	1.14E-04	
Solvent Green 3	8.995	86896.20	4.97E-03	2.32E-07	
Solvent Yellow 33	4.1	74244.54	4.24E-03	1.37E-04	
Yellow Smoke 6	6.28	7583.00	4.33E-04	7.60E-07	
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	1655414.42	9.46E-02	1.68E-01	
1,3-Dinitrobenzene (1,3-DNB)	1.49	165541.44	9.46E-03	9.96E-03	
2,4 - Dinitrophenol (2,4-DNP)	1.67				
Dinitrotoluene isomers	2.14	402784.08	2.30E-02	1.02E-02	
2,4-Dinitrotoluene	1.98				
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	25233.75	1.44E-03	8.97E-03	
Nitrobenzene (NB)	1.85				
Nitroglycerin (NG)	1.62	2362181.02	1.35E-01	1.19E-01	
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9				
Pentaerythritol Tetranitrate (PETN)	1.61	2391680.50	1.37E-01	1.23E-01	
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	16308347.85	9.32E-01	2.25E+00	

Compound	log Kow	Sum of COC Weight (g) Adjusted for 10% Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air[1] gallons
Trinitrophenylmethylnitramine (Tetryl)	2.4	8268.25	4.72E-04	1.48E-04	
2,4,6-Trinitrotoluene (TNT)	1.6	16554144.24	9.46E-01	8.60E-01	

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available.
NA – Not applicable (not used).

Table 36 Continued.

Compound	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Woodpecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker
Smokes and Obscurants					
Fog Oil Smoke					
Hexachloroethane (HC) Smoke	1.05E-02	3.37E-03		2.32E-04	2.57E-05
White Phosphorous (WP) Smoke	2.62E-01	8.44E-02		**1.69E+01**	**1.69E+00**
Brass Flakes					
Graphite Flakes					
Titanium Dioxide					
Polyethylene Glycol (PEG)					
Terephthalic Acid	8.34E-02	2.68E-02			
(o-Chlorbenzol)malononitrile (CS)	6.64E-05	2.14E-05			
Dibenz(bf)-14-oxazepine (CR)					
Colored Smokes					
CI Basic Yellow 2	1.14E-05	3.66E-06			
Disperse Yellow 11	9.51E-05	3.06E-05			
Disperse Red 9	6.96E-04	2.24E-04			
Solvent Green 3	1.41E-06	4.55E-07			
Solvent Yellow 33	8.33E-04	2.68E-04			
Yellow Smoke 6	4.63E-06	1.49E-06			

Compound	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Woodpecker mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Woodpecker	LOAEL-based TQ for Woodpecker
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.02E+00	3.29E-01			
1,3-Dinitrobenzene (1,3-DNB)	6.06E-02	1.95E-02			
2,4 - Dinitrophenol (2,4-DNP)					
Dinitrotoluene isomers	6.19E-02	1.99E-02			
2,4-Dinitrotoluene					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	5.46E-02	1.76E-02			
Nitrobenzene (NB)					
Nitroglycerin (NG)	7.27E-01	2.34E-01			
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)					
Pentaerythritol Tetranitrate (PETN)	7.46E-01	2.40E-01			
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	1.37E+01	4.40E+00	2.25E-02	**1.97E+00**	**1.67E+00**
Trinitrophenylmethylnitramine (Tetryl)	8.98E-04	2.89E-04	5.90E-06		
2,4,6-Trinitrotoluene (TNT)	5.24E+00	1.69E+00	2.87E-02	**2.41E+00**	9.47E-02

1 - NI indicates installation reports using fog oil or additives, but the amount used is not available.
Bold values indicate exceedance of regulatory threshold.

Table 37. Exposure and risk estimates for Fort Sill, Oklahoma.

Compound	log Kow	Sum of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons
Smokes and Obscurants					
Fog Oil Smoke					NA
Hexachloroethane (HC) Smoke	3.74	1053240.82	4.20E-03	2.19E-04	

Compound	log Kow	Sum of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons
White Phosphorous (WP) Smoke	3.08				
Brass Flakes	-0.52				NA
Graphite Flakes					NA
Titanium Dioxide	2.23				
Polyethylene Glycol (PEG)	-1.2				
Terephthalic Acid	2	209716.68	8.37E-03	4.46E-03	
(o-Chlorbenzol)malononitrile (CS)	2.76	22559.42	9.01E-04	1.74E-04	
Dibenz(bf)-14-oxazepine (CR)	3.49				
Colored Smokes					
CI Basic Yellow 2	3.54				
Disperse Yellow 11	4.54				
Disperse Red 9	4.045	18847.04	7.52E-04	2.61E-05	
Solvent Green 3	8.995	340249.45	1.36E-02	6.34E-07	
Solvent Yellow 33	4.1	179246.54	7.16E-03	2.31E-04	
Yellow Smoke 6	6.28				
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	88026.22	3.51E-03	6.23E-03	
1,3-Dinitrobenzene (1,3-DNB)	1.49	88026.22	3.51E-03	3.70E-03	
2,4 – Dinitrophenol (2,4-DNP)	1.67				
Dinitrotoluene isomers	2.14				
2,4-Dinitrotoluene	1.98				
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16				
Nitrobenzene (NB)	1.85				
Nitroglycerin (NG)	1.62				

Compound	log Kow	Sum of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)	1.9				
Pentaerythritol Tetranitrate (PETN)	1.61				
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	1602454.32	6.40E-02	1.54E-01	
Trinitrophenylmethylnitramine (Tetryl)	2.4	0.00			
2,4,6-Trinitrotoluene (TNT)	1.6	880262.22	3.51E-02	3.19E-02	

Table 37 Continued.

Compound	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Black-Capped Vireo mg/kg-day	LOAEL-based TQ for Plants	NOAEL-based TQ for Black-Capped Vireo	LOAEL-based TQ for Black-Capped Vireo
Smokes and Obscurants					
Fog Oil Smoke					
Hexachloroethane (HC) Smoke	1.34E-03	6.40E-04		4.4E-04	2.0E-04
White Phosphorous (WP) Smoke					
Brass Flakes					
Graphite Flakes					
Titanium Dioxide					
Polyethylene Glycol (PEG)					
Terephthalic Acid	2.72E-02	1.30E-02			
(o-Chlorbenzol)malononitrile (CS)	1.06E-03	5.07E-04			
Dibenz(bf)-14-oxazepine (CR)					
Colored Smokes					
CI Basic Yellow 2					
Disperse Yellow 11					
Disperse Red 9	1.59E-04	7.62E-05			

Compound	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Black-Capped Vireo mg/kg-day	LOAEL-based TQ for Plants	NOAEL-based TQ for Black-Capped Vireo	LOAEL-based TQ for Black-Capped Vireo
Solvent Green 3	3.86E-06	1.85E-06			
Solvent Yellow 33	1.41E-03	6.73E-04			
Yellow Smoke 6					
Dye Yellow 4 (Benzanthrone)					
Military Unique Compounds					
1,3,5-Trinitrobenzene (1,3,5-TNB)	3.79E-02	1.82E-02			
1,3-Dinitrobenzene (1,3-DNB)	2.25E-02	1.08E-02			
2,4 - Dinitrophenol (2,4-DNP)					
Dinitrotoluene isomers					
2,4-Dinitrotoluene					
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)					
Nitrobenzene (NB)					
Nitroglycerin (NG)					
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)					
Pentaerythritol Tetranitrate (PETN)					
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	9.39E-01	4.50E-01	1.5E-03	2.0E-01	1.7E-01
Trinitrophenylmethylnitramine (Tetryl)					
2,4,6-Trinitrotoluene (TNT)	1.94E-01	9.32E-02	1.1E-03	1.3E-01	5.2E-03

1 – Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 38. Exposure and risk estimates for Fort Jackson, South Carolina.

Compound	log Kow	Sum of COC Weight (g) Adjusted for 10% Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww
Smokes and Obscurants								
Fog Oil Smoke					3.30E+02	4.34E+01	1.15E+02	7.66E+01
Hexachloroethane (HC) Smoke	3.74							
White Phosphorous (WP) Smoke	3.08	22058183.9	3.78E+00	4.76E-01				
Brass Flakes	-0.52				NA			
Graphite Flakes					NA			
Titanium Dioxide	2.23							
Polyethylene Glycol (PEG)	-1.2							
Terephthalic Acid	2	756224.12	1.30E-01	6.91E-02				
(o-Chlorbenzol)malononitrile (CS)	2.76	5294.61	9.08E-04	1.75E-04				
Dibenz(bf)-14-oxazepine (CR)	3.49							
Colored Smokes								
CI Basic Yellow 2	3.54							
Disperse Yellow 11	4.54	10957.20	1.88E-03	3.37E-05				
Disperse Red 9	4.045	24118.97	4.13E-03	1.43E-04				
Solvent Green 3	8.995	17310.60	2.97E-03	1.39E-07				
Solvent Yellow 33	4.1	32620.21	5.59E-03	1.80E-04				
Yellow Smoke 6	6.28							
Dye Yellow 4 (Benzanthrone)	4.81							
Military Unique Compounds								
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	91610.65	1.57E-02	2.78E-02				
1,3-Dinitrobenzene (1,3-DNB)	1.49	91610.65	1.57E-02	1.65E-02				
2,4 - Dinitrophenol (2,4-DNP)	1.67							

Compound	log Kow	Sum of COC Weight (g) Adjusted for 10% Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww	Concentration on Tree Leaves from Direct Deposition mg/kg ww
Dinitrotoluene isomers	2.14	3475.80	5.96E-04	2.63E-04				
2,4-Dinitrotoluene	1.98							
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16							
Nitrobenzene (NB)	1.85							
Nitroglycerin (NG)	1.62	3802.81	6.52E-04	5.77E-04				
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)	1.9							
Pentaerythritol Tetranitrate (PETN)	1.61	9839.72	1.69E-03	1.51E-03				
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	662400.21	1.14E-01	2.74E-01				
Trinitrophenylmethylnitramine (Tetryl)	2.4							
2,4,6-Trinitrotoluene (TNT)	1.6	916106.54	1.57E-01	1.43E-01				
NA – not applicable (not used)								

Table 38 Continued.

Compound	Total Deposition on Tree Leaves $\mu g/cm^2$	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Woodpecker mg/kg-day
Smokes and Obscurants				
Fog Oil Smoke	1.15E+02	8.80E+01	4.67E+02	1.50E+02
Hexachloroethane (HC) Smoke				
White Phosphorous (WP) Smoke			2.90E+00	9.34E-01
Brass Flakes				

Compound	Total Deposition on Tree Leaves µg/cm^2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Woodpecker mg/kg-day
Graphite Flakes				
Titanium Dioxide				
Polyethylene Glycol (PEG)				
Terephthalic Acid			4.21E-01	1.35E-01
(o-Chlorbenzol)malononitrile (CS)			1.07E-03	3.44E-04
Dibenz(bf)-14-oxazepine (CR)				
Colored Smokes				
CI Basic Yellow 2				
Disperse Yellow 11			2.05E-04	6.60E-05
Disperse Red 9			8.74E-04	2.81E-04
Solvent Green 3			8.44E-07	2.72E-07
Solvent Yellow 33			1.10E-03	3.54E-04
Yellow Smoke 6				
Dye Yellow 4 (Benzanthrone)				
Military Unique Compounds				
1,3,5-Trinitrobenzene (1,3,5-TNB)			1.69E-01	5.46E-02
1,3-Dinitrobenzene (1,3-DNB)			1.01E-01	3.24E-02
2,4 - Dinitrophenol (2,4-DNP)				
Dinitrotoluene isomers			1.60E-03	5.16E-04
2,4-Dinitrotoluene				
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)				
Nitrobenzene (NB)				
Nitroglycerin (NG)			3.51E-03	1.13E-03
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)				
Pentaerythritol Tetranitrate (PETN)			9.21E-03	2.97E-03
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)			1.67E+00	5.37E-01

Compound	Total Deposition on Tree Leaves μg/cm^2	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[2] mg/kg bw	Dose to Woodpecker mg/kg-day
Trinitrophenylmethylnitramine (Tetryl)				
2,4,6-Trinitrotoluene (TNT)			8.69E-01	2.80E-01

1 - Concentration in aquatic insects estimated via equilibrium partitioning with sediment.

2 - Concentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

Table 38 Continued.

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker
Smokes and Obscurants						
Fog Oil Smoke	**2.1E+00**	**1.7E+00**	**2.1E+00**	**1.7E+00**		
Hexachloroethane (HC) Smoke						
White Phosphorous (WP) Smoke					**1.9E+02**	**1.9E+01**
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						
Polyethylene Glycol (PEG)						
Terephthalic Acid						
(o-Chlorbenzol)malononitrile (CS)						
Dibenz(bf)-14-oxazepine (CR)						
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11						
Disperse Red 9						
Solvent Green 3						

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Wood-pecker	LOAEL-based TQ for Wood-pecker
Solvent Yellow 33						
Yellow Smoke 6						
Dye Yellow 4 (Benzanthrone)						
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)						
1,3-Dinitrobenzene (1,3-DNB)						
2,4 - Dinitrophenol (2,4-DNP)						
Dinitrotoluene isomers						
2,4-Dinitrotoluene						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)						
Nitrobenzene (NB)						
Nitroglycerin (NG)						
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)						
Pentaerythritol Tetranitrate (PETN)						
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		2.7E-03		2.7E=03	2.41E+00	2.0E-01
Trinitrophenylmethylnitramine (Tetryl)						
2,4,6-Trinitrotoluene (TNT)		4.8E-03		4.8E-03	4.00E-01	1.6E-02
Bold values indicate exceedance of regulatory threshold.						

Table 39. Exposure and risk tables for Camp Bullis, Texas.

Compound	log Kow	Sum of COC Weight (g) (100% of material)	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in Terrestrial Insects[1] mg/kg bw
Smokes and Obscurants						
Fog Oil Smoke					NI	
Hexachloroethane (HC) Smoke	3.74	933486.76	6.33E-02	3.30E-03		2.01E-02
White Phosphorous (WP) Smoke	3.08					
Brass Flakes	-0.52				NI	
Graphite Flakes					NI	
Titanium Dioxide	2.23					
Polyethylene Glycol (PEG)	-1.2					
Terephthalic Acid	2					
(o-Chlorbenzol)malononitrile (CS)	2.76					
Dibenz(bf)-14-oxazepine (CR)	3.49					
Colored Smokes						
CI Basic Yellow 2	3.54					
Disperse Yellow 11	4.54	561.78	3.81E-05	6.82E-07		4.15E-06
Disperse Red 9	4.045					
Solvent Green 3	8.995					
Solvent Yellow 33	4.1					
Yellow Smoke 6	6.28					
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	93348.68	6.33E-03	1.12E-02		6.83E-02
1,3-Dinitrobenzene (1,3-DNB)	1.49	9334.87	6.33E-04	6.66E-04		4.06E-03
2,4 – Dinitrophenol (2,4-DNP)	1.67					
Dinitrotoluene isomers	2.14					
2,4-Dinitrotoluene	1.98					

Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16					
Nitrobenzene (NB)	1.85					
Nitroglycerin (NG)	1.62	2493.11	1.69E-04	1.50E-04		9.11E-04
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)	1.9					
Pentaerythritol Tetranitrate (PETN)	1.61					
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	1818104.86	1.23E-01	2.97E-01		1.81E+00
Trinitrophenylmethylnitramine (Tetryl)	2.4					
2,4,6-Trinitrotoluene (TNT)	1.6	933486.76	6.33E-02	5.75E-02		3.50E-01

1 – Consentration in terrestrial insects estimated via equilibrium partitioning with tree leaves.

NI – Installation reports using fog oil or additives, but the amount used is not available.

Table 39. Continued.

Compound	Dose to Black-Capped Vireo mg/kg-day	Dose to Golden-Cheeked Warbler mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Black-Capped Vireo	LOAEL-based TQ for Black-Capped Vireo	NOAEL-based TQ for Golden-Cheeked Warbler	LOAEL-based TQ for Golden-Cheeked Warbler
Smokes and Obscurants							
Fog Oil Smoke							
Hexachloroethane (HC) Smoke	9.62E-03	9.62E-03		6.6E-04	7.3E-05	6.6E-04	7.3E-05
White Phosphorous (WP) Smoke							
Brass Flakes							
Graphite Flakes							
Titanium Dioxide							
Polyethylene Glycol (PEG)							
Terephthalic Acid							
(o-Chlorbenzol)malononitrile (CS)							
Dibenz(bf)-14-oxazepine (CR)							

Compound	Dose to Black-Capped Vireo mg/kg-day	Dose to Golden-Cheeked Warbler mg/kg-day	LOAEL-based TQ for Plants and Tree Leaves	NOAEL-based TQ for Black-Capped Vireo	LOAEL-based TQ for Black-Capped Vireo	NOAEL-based TQ for Golden-Cheeked Warbler	LOAEL-based TQ for Golden-Cheeked Warbler
Colored Smokes							
CI Basic Yellow 2							
Disperse Yellow 11	1.99E-06	1.99E-06					
Disperse Red 9							
Solvent Green 3							
Solvent Yellow 33							
Yellow Smoke 6							
Dye Yellow 4 (Benzanthrone)							
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)	3.27E-02	3.27E-02					
1,3-Dinitrobenzene (1,3-DNB)	1.94E-03	1.94E-03					
2,4 - Dinitrophenol (2,4-DNP)							
Dinitrotoluene isomers							
2,4-Dinitrotoluene							
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)							
Nitrobenzene (NB)							
Nitroglycerin (NG)	4.36E-04	4.36E-04					
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)							
Pentaerythritol Tetranitrate (PETN)	8.66E-01	8.66E-01	3.0E-03	3.9E-01	3.3E-01	3.9E-01	3.3E0-01
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)							
Trinitrophenylmethylnitramine (Tetryl)	1.68E-01	1.68E-01	1.9E-03	2.4E-01	9.4E-03	2.4E-01	9.4E-03
2,4,6-Trinitrotoluene (TNT)							

Table 40. Exposure and risk estimates for Fort Hood, Texas.

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
Smokes and Obscurants							
Fog Oil Smoke					1.76E+03	2.31E+02	6.13E+02
Hexachloroethane (HC) Smoke	3.74	90666.63	7.77E-03	4.05E-04			
White Phosphorous (WP) Smoke	3.08	4850364.48	4.16E-01	5.23E-02			
Brass Flakes	-0.52				NI		
Graphite Flakes					NI		
Titanium Dioxide	2.23						
Polyethylene Glycol (PEG)	-1.2						
Terephthalic Acid	2						
(o-Chlorbenzol)malononitrile (CS)	2.76	20764.16	1.78E-03	3.44E-04			
Dibenz(bf)-14-oxazepine (CR)	3.49						
Colored Smokes							
CI Basic Yellow 2	3.54						
Disperse Yellow 11	4.54	5469.17	4.69E-04	8.40E-06			
Disperse Red 9	4.045	657.22	5.63E-05	1.95E-06			
Solvent Green 3	8.995	32.72	2.80E-06	1.31E-10			
Solvent Yellow 33	4.1	1102.24	9.45E-05	3.05E-06			
Yellow Smoke 6	6.28						
Military Unique Compounds							
1,3,5-Trinitrobenzene (1,3,5-TNB)	1.1	589352.02	5.05E-02	8.95E-02			
1,3-Dinitrobenzene (1,3-DNB)	1.49	589352.02	5.05E-02	5.32E-02			
2,4 – Dinitrophenol (2,4-DNP)	1.67						
Dinitrotoluene isomers	2.14	354054.05	3.03E-02	1.34E-02			

Compound	log Kow	Sum of COC Weight (g) Adjusted for Dud Rate	Soil Concentration (top 5 cm dry) mg/kg dw	Concentration in Vegetation via Root Uptake mg/kg ww	Mass of smokes Fog Oil and additives into air gallons	Concentration in sediment - deposition (top 1 cm dry) mg/kg dw	Concentration on Plants from Direct Deposition mg/kg ww
2,4-Dinitrotoluene	1.98						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.16	6297.26	5.40E-04	3.36E-03			
Nitrobenzene (NB)	1.85						
Nitroglycerin (NG)	1.62	425323.03	3.65E-02	3.23E-02			
Nitrophenol isomers (e.g. 2 – Nitrophenol; 4 – Nitrophenol)	1.9						
Pentaerythritol Tetranitrate (PETN)	1.61	955696.17	8.19E-02	7.35E-02			
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	0.87	855958.97	7.34E-02	1.77E-01			
Trinitrophenylmethylnitramine (Tetryl)	2.4	140.55	1.20E-05	3.76E-06			
2,4,6-Trinitrotoluene (TNT)	1.6	5893520.16	5.05E-01	4.59E-01			

Table 40 Continued.

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves µg/cm²	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Black-Capped Vireo mg/kg-day	Dose to Golden-Cheeked Warbler mg/kg-day
Smokes and Obscurants						
Fog Oil Smoke	4.09E+02	6.13E+02	4.69E+02	2.49E+03	1.19E+03	1.19E+03
Hexachloroethane (HC) Smoke		6.08E-04		2.47E-03	1.18E-03	1.18E-03
White Phosphorous (WP) Smoke		7.85E-02		3.19E-01	1.53E-01	1.53E-01
Brass Flakes						
Graphite Flakes						
Titanium Dioxide						

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves $\mu g/cm^2$	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Black-Capped Vireo mg/kg-day	Dose to Golden-Cheeked Warbler mg/kg-day
Polyethylene Glycol (PEG)						
Terephthalic Acid						
(o-Chlorbenzol)malononitrile (CS)		5.15E-04		2.09E-03	1.00E-03	1.00E-03
Dibenz(bf)-14-oxazepine (CR)						
Colored Smokes						
CI Basic Yellow 2						
Disperse Yellow 11		1.26E-05		5.12E-05	2.45E-05	2.45E-05
Disperse Red 9		2.93E-06		1.19E-05	5.70E-06	5.70E-06
Solvent Green 3		1.96E-10		7.98E-10	3.82E-10	3.82E-10
Solvent Yellow 33		4.57E-06		1.86E-05	8.89E-06	8.89E-06
Yellow Smoke 6						
Military Unique Compounds						
1,3,5-Trinitrobenzene (1,3,5-TNB)		1.34E-01		5.45E-01	2.61E-01	2.61E-01
1,3-Dinitrobenzene (1,3-DNB)		7.98E-02		3.24E-01	1.55E-01	1.55E-02
2,4 - Dinitrophenol (2,4-DNP)						
Dinitrotoluene isomers		2.01E-02		8.17E-02	3.91E-02	3.91E-02
2,4-Dinitrotoluene						
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)		5.03E-03		2.04E-02	9.79E-03	9.79E-03
Nitrobenzene (NB)						
Nitroglycerin (NG)		4.84E-02		1.96E-01	9.41E-02	9.41E-02
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)						
Pentaerythritol Tetranitrate (PETN)		1.10E-01		4.47E-01	2.14E-01	2.14E-01
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		2.65E-01		1.08E+00	5.16E-01	5.16E-01

Compound	Concentration on Tree Leaves from Direct Deposition mg/kg ww	Total Deposition on Tree Leaves µg/cm²	Concentration in Aquatic Insects[1] mg/kg bw	Concentration in Terrestrial Insects[1] mg/kg bw	Dose to Black-Capped Vireo mg/kg-day	Dose to Golden-Cheeked Warbler mg/kg-day
Trinitrophenylmethylnitramine (Tetryl)		5.64E-06		2.29E-05	1.10E-05	1.10E-05
2,4,6-Trinitrotoluene (TNT)		6.89E-01		2.80E+00	1.34E+00	1.34E+00
1 – Concentration in aquatic insects estimated via equilibrium partitioning with sedimtne.						

Table 40 Continued.

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Black-Capped Vireo	LOAEL-based TQ for Black-Capped Vireo	NOAEL-based TQ for Golden-Cheeked Warbler	LOAEL-based TQ for Golden-Cheeked Warbler
Smokes and Obscurants								
Fog Oil Smoke	**1.1E+01**	**8.9E+00**	**1.1E+01**	**8.9E+00**				
Hexachloroethane (HC) Smoke					8.2E-05	9.1E-06	8.2E-05	9.0E-06
White Phosphorous (WP) Smoke					**3.1E+01**	**3.1E+00**	**3.1E+01**	**3.1E+00**
Brass Flakes								
Graphite Flakes								
Titanium Dioxide								
Polyethylene Glycol (PEG)								
Terephthalic Acid								
(o-Chlorbenzol)malononitrile (CS)								
Dibenz(bf)-14-oxazepine (CR)								
Colored Smokes								
CI Basic Yellow 2								
Disperse Yellow 11								

Compound	NOAEL-based TQ for Plants	LOAEL-based TQ for Plants	NOAEL-based TQ for Tree Leaves	LOAEL-based TQ for Tree Leaves	NOAEL-based TQ for Black-Capped Vireo	LOAEL-based TQ for Black-Capped Vireo	NOAEL-based TQ for Golden-Cheeked Warbler	LOAEL-based TQ for Golden-Cheeked Warbler
Disperse Red 9								
Solvent Green 3								
Solvent Yellow 33								
Yellow Smoke 6								
Dye Yellow 4 (Benzanthrone)								
Military Unique Compounds								
1,3,5-Trinitrobenzene (1,3,5-TNB)								
1,3-Dinitrobenzene (1,3-DNB)								
2,4 - Dinitrophenol (2,4-DNP)								
Dinitrotoluene isomers								
2,4-Dinitrotoluene								
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)								
Nitrobenzene (NB)								
Nitroglycerin (NG)								
Nitrophenol isomers (e.g. 2 - Nitrophenol; 4 - Nitrophenol)								
Pentaerythritol Tetranitrate (PETN)								
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)		1.8E-03		1.8E-03	2.3E-01	2.0E-01	2.3E-01	2.0E-01
Trinitrophenylmethylnitramine (Tetryl)		1.5E-07		1.5E-07				
2,4,6-Trinitrotoluene (TNT)		1.5E-02		1.5E-07	**1.9E+00**	7.5E-02	**1.9E+00**	7.5E-02
Bold values indicate exceedance of regulatory threshold.								

7 Uncertainty Analysis

The analyses presented here relied on screening level approaches and calculations together with site-specific information on S&O and munition usage and impact area to predict the potential for adverse effects to the selected threatened and endangered species. In most cases, calculations were designed to represent reasonable upper-bound estimates of potential exposures. Sources of uncertainty, data limitations, and the potential relationship to drawing the conclusions are presented as follows.

Installation-specific S&O and MUC usage: Researchers relied on data obtained for fiscal year 2002 from each installation as to the quantity of each munition fired. The quantity and type of munitions used varies from year to year. For example, some installations reported no fog oil usage for 2002 but they have used it in the past and nothing is precluding them from using it in future. Similarly, the amount of any specific grenade type used varies from year to year. It is unknown whether this over- or underestimates potential risk. Obtaining data over many years (e.g., a 10-year time period) would allow a probabilistic approach to be used, in which usage data would be described by distributions rather than point estimates.

COC buildup in the environment: The analysis presented here is conducted on an annualized basis. This essentially assumes that the environment is in steady-state; that is, the amount of chemicals entering and leaving the system is roughly equivalent. However, firing grenades into an impact area over many years may result in higher environmental concentrations than predicted here, given the specific physical-chemical properties of each of the COCs. To address this potential source of uncertainty, this research assumed both a 10 percent dud rate (most realistic) and a 100 percent dud rate (that is, the entire amount of COCs contained in the munitions are deposited over the impact area). This is equivalent to the conservative assumption that this quantity of munitions would be used over a 10-year period with no loss of COCs.

COC database from MIDAS/TRI-DDS: Researchers estimated the quantity of each COC in each munition by DODIC using the procedure described previously, which relied on the TRI-DDS and MIDAS databases. In working with these databases, researchers noted discrepancies between the summary sheets and the individual DODIC reports, as well as multiple entries for any (in theory) unique DODIC-NSN combination. There were many instances in which a DODIC-NSN combination re-

sulted in several different constituent breakdowns, which were completely different (e.g., a different COC list between the two). The impact of these differences is unknown, but is presumed to be minimal.

Degradation products: TNT in particular, and to a lesser extent RDX and HMX, develop degradation products in the environment. Some of these are included on the COC list (e.g., 1,3,5-trinitrobenzene, 1,3-dinitrobenzene). Without having detailed site-specific environmental parameters, it is difficult to predict what the expected concentrations of these constituents are at any given installation or site. Moreover, there are additional breakdown products that were not included on the COC list that are potential contributors to risk, including 3,5-dinitroaniline and 2-amino-4,6-dinitrotoluene. The most efficient way to reduce this uncertainty is to develop site-specific sampling plans at each installation, which would provide actual concentration estimates in soil, vegetation, and other environmental media.

Fate and transport estimates:

Dud rate: This analysis assumed a 10 percent dud rate for the munitions. This is higher than the average dud rate across all DODICs. However, the actual dud rate could be greater, which would increase the risk estimates presented here. No dud rate was assumed for the colored smokes.

Fog oil: For fog oil, the screening-level analysis resulted in estimates of maximum deposition together with installation-specific values for actual fog oil use. More sophisticated modeling approaches, for example using the Hazard Production and Assessment Capability (HPAC) system models of release and transport of materials in the atmosphere, together with site-specific meteorology and knowledge of terrain, are possible but were beyond the scope of this analysis.

Plant uptake: This analysis used a regression equation developed for a large number of organic chemicals based on the Log K_{ow} to estimate potential uptake of munitions and smokes and obscurants into plants and trees. It is unknown whether this equation over- or under-estimates potential uptake for any given chemical due to unknown factors such as potential transformation processes (e.g., degradation, etc.) that the chemical may be subject to in the environment. This analysis assumed that all of the chemical mass was available for uptake into plants, which is conservative given that some of the COCs are known to degrade a certain amount relatively quickly in specific environments. In addition, the same equation was used for both plants and grasses as well as tree leaves, although the equation was not developed specifically for tree leaves. There are some data available for a few of the munitions (e.g., TNT, RDX) to develop empirical uptake factors and these could be used to compare to the predictions from the regression equation. Synoptic sampling of

soil, vegetation likely to serve as forage for the tortoises, and leaves from trees in which the avian threatened and endangered species are found would reduce this modeling uncertainty and provide a method for developing empirical relationships between soil and vegetation concentrations.

Direct deposition on plants: For fog oil, the analysis assumed vegetation yields for plants/grasses and tree leaves based on "generic" literature values designed to encompass a number of plant types rather than any specific vegetation, and further assumed no interception fraction (that is, the entire amount of fog oil available for deposition would fall onto plants and/or trees, even though this is almost certainly not really the case). Further, the analysis assumes no loss once the fog oil has landed on the foliage. Thus, these estimates are designed to overestimate potential concentrations. More sophisticated modeling could be used to refine these estimates (e.g., installation-specific fog oil deposition estimates using HPAC together with installation-specific knowledge of foliage and vegetation yield and interception fractions specific to the foliage type). A probabilistic analysis could incorporate the uncertainty in these parameters. An additional approach would be to measure fog oil concentrations at each installation at specified time intervals following a training exercise. Where this has been done at select installations, more site-specific modeling is a reasonable approach.

Food/prey concentrations: This screening level assessment assumes equilibrium partitioning for sediment to generic benthic invertebrates, and tree leaves to generic terrestrial insects that live in trees such as caterpillars, beetles, etc. Equilibrium partitioning is typically considered an upper-bound estimate in that it does not account for chemical decay, metabolism, and so on. However, if the exposure estimates in the sediment or tree leaves are underpredicted, then the resulting equilibrium concentrations in the organisms are likely underpredicted as well. It is unknown whether the estimates presented here are high or low and how high or low relative to actual concentrations. The gold standard would be to collect synoptic data on tree leaves and terrestrial insects to explore the relationship between the concentrations, and also to evaluate the absolute concentrations in the insects at any given installation.

Biological parameters: The screening level assessment relies on literature estimates for lipid content of plants and tree leaves, lipid content of benthic invertebrates and terrestrial insects, total organic carbon in sediment, vegetation yield, and soil/sediment bulk density. Collection of installation-specific biological parameters would reduce this source of uncertainty.

Physical-chemical parameters: A critical physical-chemical parameter in terms of modeling is the Log K_{ow} (octanol-water partition coefficient). This coefficient de-

scribes the affinity a chemical has for the lipid, or organic, fraction of any particular environmental medium (e.g., organic carbon, etc.). This assessment uses measured values where possible, and estimates values using an accepted QSAR program available from USEPA. The K_{ow} is a very sensitive parameter, indicating that small changes in the K_{ow} result in large effects to predicted environmental concentrations. A probabilistic model using a distribution of K_{ow}s could be developed for each individual COC and the uncertainty surrounding the K_{ow} input on risk could be quantified.

Exposure area: Installations provided estimates of the area over which munitions are distributed (the impact area). The actual area may be larger or smaller than presented here. A smaller area would increase predicted environmental concentrations, while a larger area would decrease environmental concentrations. Changes in impact area could be quantitatively evaluated through a probabilistic framework. This assessment assumes a unit 1 km by 1 km deposition area for S&Os. Installation-specific modeling could be conducted to reduce this source of uncertainty.

Exposure parameters: This assessment relies on literature sources for exposure parameters, including body weight and ingestion rate for threatened and endangered species of concern. Uncertainty introduced as a result of these exposure parameters is likely to be moderate to low and could be quantitatively evaluated using a probabilistic framework. This assessment further assumes that the threatened and endangered species of concern would forage exclusively over the impact area, which is in all but one case 15 mi^2 or greater. However, threatened and endangered species of concern may forage over unimpacted areas as well. A site-use factor (defined as a point estimate or as a distribution or range) could be used in a model to evaluate the quantitative impact of this source of uncertainty.

Exposure pathways: This assessment focuses on long-term exposures via ingestion to residual COCs in the environment from training and maneuver activities. Many of these COCs have known adverse effects via inhalation, particularly in the short-term. Some of the COCs may also have potential effects via dermal absorption. Risk may be underestimated because these exposure routes are not quantitatively evaluated in this assessment.

Toxicity Reference Values: TRVs are selected or developed based on the best available information. In many cases, data are simply not available for developing TRVs. These data gaps could be addressed by conducting toxicity studies for COCs. There is always uncertainty in the application of TRVs, which can be quantitatively evaluated in a probabilistic framework for those COCs for which some data are available.

In general, a probabilistic framework allows for a quantitative evaluation of sources of uncertainty and the magnitude of each source on predicted risk. Additional data collection (e.g., concentrations in the environment, relationships between environmental components such as sediment and benthos, etc.) as well as more refined modeling using installation-specific meteorology, terrain, knowledge of vegetation and soil types, etc. would help to reduce sources of uncertainty and provide more refined risk estimates. A probabilistic framework in which distributions instead of point estimates are used for input parameters would provide a quantitative expression of the uncertainty (e.g., a distribution of predicted risks rather than a single number for each receptor-COC pathway combination). It would also provide a means for identifying predominant contributors to uncertainty (e.g., does the K_{ow} or the ingestion rate contribute more to the uncertainty in predicted risk estimates?).

8 Conclusions and Recommendations

Predicted toxicity quotients indicate potential adverse effects via food web exposures as a result of munition buildup in the environment. Specifically, potential adverse effects from exposure to munitions are indicated for the red-cockaded woodpecker, black-capped vireo, golden-cheeked warbler, gray bat, and the Indiana bat. There is no risk to tortoises from exposure to munitions. Potential adverse effects to all threatened and endangered species of concern are indicated from exposure to white phosphorus smoke. Table 41 provides a summary of exceedances assuming both 10 percent and 100 percent dud rates for munitions.

Table 41. Summary of exceedances for predicted toxicity quotients for each installation.

Installation	Impact Area (mi^2)	Dud Rate	Vegetation LOAEL	Avian NOAEL	Avian LOAEL	Tortoise NOAEL	Tortoise LOAEL	Mammal NOAEL	Mammal LOAEL
Fort Rucker, AL	22	100%	None	NA	NA	None	None	NA	NA
Yuma Proving Ground, AZ	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Fort Irwin, CA	159	100%	None	NA	NA	None	None	NA	NA
Fort Benning, GA	25	10%	FO	WP	None	None	None	NA	NA
		100%	FO	WP, RDX, TNT	RDX	None	None		
Fort Gordon, GA	19	100%	None	None	None	None	None	NA	NA
Fort Stewart, GA	30	10%	None	WP, TNT	WP	None	None	NA	NA
		100%	None	WP, RDX, TNT	WP, RDX	None	None		
Fort Campbell, KY	39	10%	None	NA	NA	NA	NA	WP	WP
		100%	None					WP, RDX, TNT, NG, 1,3-DNB	WP, 1,3-DNB
Fort Knox, KY	158	10%	None	NA	NA	NA	NA	FO	None
		100%	None					FO	None
Fort Polk, LA	13	10%	None	WP, RDX, TNT	WP, RDX	NA	NA	NA	NA
		100%	None	WP, RDX, TNT	WP, RDX, TNT				
Camp Shelby, MS	12	10%	FO	WP, TNT	WP	FO	None	NA	NA
		100%	FO	WP, RDX, TNT	WP, RDX, TNT	FO	None		

<table>
<tr><th>Installation</th><th>Impact Area (mi^2)</th><th>Dud Rate</th><th>Vegetation LOAEL</th><th>Avian NOAEL</th><th>Avian LOAEL</th><th>Tortoise NOAEL</th><th>Tortoise LOAEL</th><th>Mammal NOAEL</th><th>Mammal LOAEL</th></tr>
<tr><td rowspan="2">Fort Leonard Wood, MO</td><td rowspan="2">0.79</td><td>10%</td><td>FO</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td>FO, 1,3,5-TNB, 1,3-DNB, RDX, TNT</td><td>FO, 1,3-DNB, RDX, TNT</td></tr>
<tr><td>100%</td><td>FO, RDX, TNT</td><td>FO, TA, 1,3-DNB, RDX, TNT, PETN, NG, 1,3,5-TNB</td><td>FO, RDX, TNT, 1,3-DNB, 1,3,5-TNB</td></tr>
<tr><td rowspan="2">Fort Bragg, NC</td><td rowspan="2">51</td><td>10%</td><td>None</td><td>WP, RDX, TNT</td><td>WP, RDX</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td></tr>
<tr><td>100%</td><td>None</td><td>WP, RDX, TNT</td><td>WP, RDX</td></tr>
<tr><td rowspan="2">Fort Sill, OK</td><td rowspan="2">73</td><td>10%</td><td rowspan="2">None</td><td rowspan="2">None</td><td rowspan="2">None</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td></tr>
<tr><td>100%</td></tr>
<tr><td rowspan="2">Fort Jackson, SC</td><td rowspan="2">17</td><td>10%</td><td>FO</td><td>WP</td><td>WP</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td></tr>
<tr><td>100%</td><td>FO</td><td>WP, RDX, TNT</td><td>WP, RDX</td></tr>
<tr><td rowspan="2">Camp Bullis, TX</td><td rowspan="2">43</td><td>10%</td><td rowspan="2">None</td><td rowspan="2">None</td><td rowspan="2">None</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td></tr>
<tr><td>100%</td></tr>
<tr><td rowspan="2">Fort Hood, TX</td><td rowspan="2">34</td><td>10%</td><td>FO</td><td>WP, TNT</td><td>WP</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td><td rowspan="2">NA</td></tr>
<tr><td>100%</td><td>FO</td><td>WP, RDX, TNT</td><td>WP, RDX</td></tr>
<tr><td colspan="10">Notes:
None – no exceedances of TRVs.
NA – not applicable (receptor not evaluated for this Installation).
100% of fog oil, colored smokes, and smoke additives (e.g., white phosphorus, graphite flakes, brass flakes) are deposited over the impact area.
Munition dud rate is either 10% (realistic) or 100% (equivalent to 10 years of deposition at a 10% dud rate with no COC loss).</td></tr>
</table>

This screening level assessment of potential chronic risk to threatened and endangered species of concern from exposure to S&Os and MUCs used at training and maneuver exercises at U.S. Army installations is installation-specific where possible, and could be further refined with additional installation-specific data to more precisely estimate potential risk. The following provides a list of limitations, uncertainties, and/or recommended analyses:

- This assessment relies on data and information obtained directly from contacts at each installation. Installation-specific data was not collected and visits were not made to any of the installations. Range characterization studies could be designed that specifically identify the nature and extent of surface

soil contamination in and around impact and training areas (see, for example, Pennington et al. 2001). More site-specific data and information could be included within a modeling framework (e.g., concentrations of COCs in the environment, biological surveys, site-specific knowledge of vegetation and foliage types to parameterize the model etc.).

- This assessment uses maximum predicted fog oil deposition rates from the literature (Driver 1993; Getz et al. 1996). Conducting site-specific dispersion modeling based on S&O usage and site-specific meteorology was beyond the scope of this effort. However, it is possible to develop site-specific dispersion models using the HPAC modeling system together with detailed information on meteorology, S&O usage, and terrain.
- An implicit assumption in this assessment is that receptors would forage 100 percent of the time over the impact area, when in fact they may spend only a portion of their time in this area.
- This analysis does not consider soil runoff into water due to the complexity of modeling and the lack of suitable data to constrain assumptions. This pathway could be evaluated using the Universal Soil Loss Equation together with site-specific information on soil type, slope, watershed area, and other parameters.
- The only receptors assumed to be consuming aquatic insects are the gray and Indiana bats. Given a consistent set of assumptions (e.g., fog oil is distributed over a 1-km by 1-km area to capture maximum deposition, etc.) the ratio of predicted aquatic invertebrate concentrations versus terrestrial insects is approximately 0.2:1. In other words, the aquatic invertebrate predicted concentration is approximately 20 percent of the terrestrial insect concentration. Therefore, TES of concern that consume primarily terrestrial insects receive a proportionally higher dose than TES that consume aquatic invertebrates. This is primarily relevant for the bats, which consume both aquatic and terrestrial insects.

There are a number of data gaps in terms of TRVs for the TES and receptor categories of concern. Literature reviews (Von Stackleberg et al. 2004, 2005) identified constituents for which data are inadequate or altogether unavailable for developing TRVs. These include:

COC	Invertebrates	Plants	Birds	Mammals	Reptile
Fog Oil Smoke	Adequate	Adequate	Inadequate	Adequate	No Data
Hexachloroethane (HC) Smoke	Inadequate	Adequate	Adequate	Adequate	No Data
White Phosphorous (WP) Smoke	Adequate	Inadequate	Adequate	Adequate	No Data
Colored Smokes	No Data	No Data	No Data	*	No Data
Brass Flakes	Adequate	Adequate	No Data	Inadequate	No Data
Graphite Flakes	Inadequate	No Data	No Data	Inadequate	No Data
Titanium Dioxide	No Data	No Data	No Data	No Data	No Data
Polyethylene Glycol (PEG)	No Data	No Data	No Data	No Data	No Data
(o-Chlorbenzol)malononitrile (CS)	No Data	No Data	No Data	No Data	No Data
Dibenz(bf)-14-oxazepine (CR)	No Data	No Data	No Data	Adequate	No Data
Terephthalic Acid	No Data	Inadequate	No Data	Adequate	No Data
1,3,5-Trinitrobenzene (1,3,5-TNB)	Adequate	No Data	No Data	Adequate	No Data
1,3-Dinitrobenzene (1,3-DNB)	Adequate	No Data	No Data	Adequate	No Data
2,4 - Dinitrophenol (2,4-DNP)	No Data	No Data	No Data	Inadequate	No Data
Dinitrotoluene isomers	Inadequate	No Data	No Data	Adequate	No Data
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	Adequate	Inadequate	No Data	Adequate	No Data
Nitrobenzene (NB)	Inadequate	Inadequate	No Data	Adequate	No Data
Nitroglycerin (NG)	Inadequate	Inadequate	No Data	Inadequate	No Data
Nitrophenol isomers (e.g. 2-Nitrophenol; 4-Nitrophenol)	Inadequate	No Data	No Data	Inadequate	No Data
Pentaerythritol Tetranitrate (PETN)	Inadequate	No Data	No Data	Inadequate	No Data
Hexahydro-1,3,5-trinitro-1,2,5-triazine (RDX)	Inadequate	Adequate	No Data	Adequate	No Data
Trinitrophenylmethylnitramine (Tetryl)	No Data	Adequate	No Data	Adequate	No Data
2,4,6-Trinitrotoluene (TNT)	Adequate	Excellent	Adequate	Excellent	**
* – data adequate to develop a TRV for Solvent Yellow 33 only.					
** – one study on dermal exposure to salamanders; not suitable for reptiles or the ingestion pathway.					

As described in the Chapter 7, Uncertainty Analysis, there are numerous uncertainties associated with each component of the modeling process. There are a number of significant data gaps that have been identified in assessing the potential for adverse effects, particularly in terms of appropriate toxicity reference values. Refining the screening level analysis to incorporate more sophisticated modeling approaches together with additional site-specific data could reduce many of the uncertainties associated with potential exposures. Specifically, the analyses could be refined by:

- Collecting installation-specific information on vegetation type and yield, soil type, and other site-specific parameters to more precisely define model parameters.

- Collecting additional installation-specific data on environmental concentrations of munitions and smoke and obscurant constituents following years of continuous use.
- Conducting installation-specific modeling of smoke and obscurant disposition in the environment using the HPAC modeling system together with site-specific meteorology, knowledge of terrain etc.
- Combining some or all of the above additional data into a probabilistic assessment to explicitly characterize uncertainty in the models and model parameters.

However, this assessment does indicate potential risk to threatened and endangered species of concern from exposure to RDX, TNT, 1,3,5-trinitrobenzene, 1,4-dinitrobenzene, white phosphorus, and fog oil as a result of their use during training and maneuver exercises at military installations.

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14. ABSTRACT

Preparation for anticipated, unknown, and invariably adverse battlefield conditions requires military training activities involving military smokes and obscurants (S&Os) and related chemical compounds, and can result in the release of other chemical agents and military unique compounds (MUCs) associated with munitions. This study evaluates the potential long-term impacts on selected threatened and endangered species resulting from dispersion and deposition of vapors and particles found in the fog oils, hexachloroethane smoke, colored smokes, white phosphorus, and obscurants such as brass flakes and graphite flakes used during training. Residue from these constituents can deposit directly on plants and prey species favored by higher vertebrates and other species or can be taken up by plants and prey species from the soil. From the literature and installation use reports, the authors develop estimates of toxicity and exposure to calculate installation-specific screening-level risk for selected threatened and endangered species.

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